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THE ROLE OF NON-VERBAL AND VERBAL COMMUNICATION IN STUDENT'S ABSTRACT UNDERSTANDING OF A TECHNOLOGICAL CONCEPT IN JUNIOR AND SENIOR HIGH INDUSTRIAL ARTS

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THE ROLE OF NON-VERBAL AND VERBAL COMMUNICATION IN STUDENTS' ABSTRACT UNDERSTANDING OF A TECHNOLOGICAL CONCEPT IN JUNIOR AND SENIOR HIGH INDUSTRIAL ARTS

EVERETT N. ISRAEL

ABSTRACT

This research was conducted to determine the premise for using instructional guidelines which would enable junior and senior high school students to develop an abstract understanding of a technical concept. The problem was to determine if the verbal instructional medium complementing the nonverbal instructional medium ($NV + V_c$) would result in students developing a higher level of abstract understanding of a pre-selected technical concept than the use of the verbal instructional medium (V) alone or the verbal instructional medium supplementing the nonverbal medium ($NV + V_s$). The study was based upon the need for students to develop a higher level of abstract understanding of industrial arts subject matter.

The procedure used for conducting the study involved (a) selecting a technical concept, (b) developing a subordinate hierarchy, (c) writing test materials to measure abstract learning, (d) producing video-taped lessons, (e) determining the reliability of the tests, (f) identifying the sample, (g) collecting the data, and (h) analyzing the data. The results of the study indicated that (a) the guidelines used to plan the verbal medium complementing the nonverbal ($NV + V_c$) lesson resulted in students acquiring the largest amount of abstract understanding of a technical principle and (b) intellectual maturation had an effect on students' abilities to develop an abstract understanding of a technical principle.

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CHAPTER I

THE PROBLEM, HYPOTHESES, AND DEFINITION OF TERMS

This study investigated the effect verbal and/or nonverbal classroom instruction had on junior and senior high school students' abstract understanding of environmentally-based concepts. After an examination of cognitive theories, Gagné's hierarchy of learning conditions and subordinate hierarchy were used to operationally define nonverbal and verbal communication in the formal instructional process.

Nonverbal and Verbal Continua

Research done by Ruesch and Kees (1961) identified that the nonverbal and verbal continua existed independent of each other. This distinction resulted in a redefinition of nonverbal communication and a remapping of the area encompassed by nonverbal communication.

Nonverbal communication research completed during the late 1930's, 40's, and early 50's operationally defined the nonverbal medium as the connotative meaning of messages (Fay & Middleton, 1939, 1940, 1941a, 1941b, 1943; Israel, 1966). The meaning of the nonverbal medium was determined by comparing the connotative medium with the denotative medium.

Ruesch and Kees' (1961) research findings, based upon the systematic observation of people's reactions to actions, objects, and events in the environment, resulted in the definition of verbal and nonverbal communication as digital and analogical codification. They signified that the nonverbal or verbal media cannot be used as a substitute for each other, but can be used to supplement or complement the other.

Digital Codification

Digital codification was defined as a language system using numbers and/or words which are dependent upon an artificial set of rules logically created and agreed upon by man (Ruesch & Kees, 1961, p. 9). (See Figure 1.) Objects and events that have occurred in the environment are described by letters which are used to produce words. The words are combined in a predetermined manner to form sentences. The logic used to combine letters into words, words into sentences, and sentences into paragraphs has been created by man.

Environment	Code (Digital)		Message
Objects and Events	Letters Phonics Words Sentences Paragraphs	Logically based	"Cut out" events from the context of the environment Subject-predicate oriented Degree of description determined by the use of adverbs and adjectives

Figure 1. Characteristics of Digital Codification (Israel, 1967)

Analogical Codification

Analogical codification was defined as "...a series of symbols that in their own proportions and relations are similar to the thing, idea, or event for which they stand (Ruesch & Kees, 1961, p. 8).

(See Figure 2.) The meaning of the code is derived from environmental events that have occurred or are occurring. Analogical codification can be used effectively to express the timing of events, the cause and effect relationships of events, the continual change that takes place in the physical environment, and space (the size, shape, and location of objects in the environment) (Ruesch & Kees, 1961, p. 190).

Environment	Code (Analogical)		Message
Objects and Events	Signs Actions Objects	Environmentally based	Context of the environment is used to determine the meaning of the codes Describes cause and effect relationships Represents the quality of space

Figure 2. Characteristics of Analogical Codification (Israel, 1967)

Differences Between Analogical and Digital Codification

Ruesch (1955) developed an extensive description of the differences between analogical and digital codification. This description was summarized by Galloway (1962, p. 25) as follows:

Analogical Codifications

1. Permit redundancies
2. Permit quick statements
3. Are subject oriented
4. Have emotional appeal
5. Facilitate understanding
6. Represent an intimate language

Digital Codifications

1. Produce fatigue when redundant
2. Necessitate long-winded statements
3. Are predicate oriented
4. Exert an intellectual appeal
5. Are apt for reaching agreement
6. Represent a distant language

Rationale for the Study

The researcher assumed that the teaching strategy used by industrial arts teachers should place emphasis on students' abstract understanding of environmentally-based concepts. This assumption was based upon national curriculum changes that have taken place in industrial arts and the nature of concept learning. Concepts provide students with (a) a means for freeing their thoughts from the control of the environment, (b) a reservoir of organized knowledge which has general application, (c) a means for processing and organizing new information, and (d) cognitive strategies for thinking and solving problems.

Nature of Concept Learning

The lack of an all-encompassing theory of cognition resulted in the citation of major cognitive theorists to describe the process of concept learning. Anderson and Ausubel (1965, p. v) reiterated this position by stating that "...no theory of cognition at the present time is sufficiently comprehensive, sophisticated, or widely enough accepted to serve adequately as the sole basis for interpreting the available research evidence."

Both Gagné and Ausubel agreed (a) that the major long-term objective of education is the acquisition of organized bodies of knowledge (Ausubel, 1965, p. 9; Gagné, 1962), (b) that bodies of knowledge be organized psychologically and not logically (Ausubel, 1968; Gagné, 1971), (c) that knowledge within the learner's cognitive structure is organized in hierarchical order (Gagné, 1965, 1970b; Ausubel, 1965, 1968), and (d) that the verbal media provide a more efficient means for students to acquire an understanding of concepts than discovery learning (Gagné, 1965, 1970b; Ausubel, 1965, 1968).

Similarities between Ausubel's and Gagné's theories were used to describe the process of students acquiring a verbal understanding of environmentally-based concepts. This process consisted of students (a) perceiving environmental stimuli, (b) assigning a verbal label to the stimuli, (c) generalizing the label to other similar stimuli, (d) identifying similarities and differences between the environmental stimuli, (e) becoming aware of and assigning new verbal labels and/or new meanings to existing verbal labels to describe the similarities and differences between environmental stimuli, and (f) categorizing the similarities and differences in a meaningful hierarchical order.

Gagné's description of the above process places emphasis on students moving from the concrete to the abstract, whereas, Ausubel's explanation stresses the opposite viewpoint. Also, Ausubel's theory includes a more detailed explanation regarding the acquisition of nonenvironmentally-based propositions and concepts. Gagné's theory is more environmentally oriented.

Need for Instructional Guidelines

Based upon the assumptions (a) that the acquisition of environmentally-based concepts does involve the procedure previously described, (b) that digital or analogical codification cannot replace each other but can supplement or complement each other, (c) that knowledge is cognitively stored in hierarchical order, and (d) that the use of the verbal media is the most efficient means for students to acquire an understanding of concepts, the following question was asked: What instructional guidelines should be utilized for structuring the use of the verbal and nonverbal media so students will acquire the greatest level of abstract (verbal) understanding of environmentally-based concepts?

Rationale for Instructional Guidelines

The performance expected of the learner was defined as a means for circumscribing the nature of the instructional guidelines. Next, the rationale was identified for testing three instructional approaches that were related to the class of performance change expected. The rationale served as a basis for identifying questions to be answered.

Performance Change Expected

Instruction is the external event which produces the internal process called learning. Learning results in a change in the learner's performance. The change cannot be associated with the process of physical growth (Gagné, 1970b, pp. v & 3).

The performance expected of the learner was his ability to develop an understanding of technical concepts. A concept was defined as "...some amount of [abstract] meaning more or less organized in an individual's mind as a result of sensory perception of external objects or events and the cognitive interpretation of the perceived data" (Woodruff, 1964, p. 84). The perceived data were limited to technical devices (artifacts) created by man as a means for controlling his physical environment. Bock (1969, p. 221) defined an artifact as "...any portion of the material environment that has been deliberately used, or modified for use, by man."

The amount of conscious meaning (understanding) the learner associated with a technical concept was used as the criteria for evaluating concept learning (Gagné, 1965, 1970b; Ausubel, 1965, 1968). Gagné identified that this criteria can be measured by the learner's ability to engage in productive thinking. Productive thinking was defined as the process of applying acquired cognitive capabilities and strategies to novel contextually-related problem solving situations (Gagné, 1959, 1962, 1964).

Three Instructional Approaches

The three approaches were based upon Gagné's discussion regarding the importance of laboratory activities and demonstrations in science (Gagné, 1970b, pp. 179 & 184).

Gagné identified that the acquisition of environmentally-based concepts requires the learner to have reference to a class of concrete situations so that he will use the concept as an accurate tool of thinking when he is dealing with the real world. The actual stimulus situations provide the student with an "operational" meaning of the environmentally-based concept (Gagné, 1970b, p. 179).

The use of the verbal medium alone and the lack of concrete references has been identified by Gagné (1970b, p. 187) as oververbalization. In novel but related problem solving situations, the learner would be unable to solve problems.

A third instructional approach that Gagné (1970b, p. 187) predicted would result in superficial verbal learning was "learning by doing." The verbal medium,used to provide directions for the learner to complete specific nonverbal tasks,would not result in him developing an abstract (verbal) understanding of environmentally-based concepts.

Questions About Approaches

The questions asked were: Did the instructional procedure using the verbal medium supplementing the nonverbal medium (learning by doing) provide students with enough information that they were able to develop an abstract understanding of technical concepts? Did the use of the verbal medium alone result in students recalling past experiences needed to acquire meaningful and accurate understanding of technical concepts to solve contextually-related problems? Did the use of the nonverbal medium complementing the verbal medium result in students developing abstract understanding of technical concepts?

Statement of the Problem

The problem was to determine if the verbal instructional medium complementing the nonverbal instructional medium would result in students developing a higher level of abstract understanding of a pre-selected technical concept than the use of the verbal instructional medium alone or the verbal instructional medium supplementing the nonverbal medium.

The verbal instructional medium alone was included to depict Gagné's oververbalization credence. The verbal instructional medium supplementing the nonverbal medium was included to depict how industrial arts teachers usually conduct their classroom presentations.

Need for the Study

A survey was conducted of the literature related to major industrial arts curriculum plans developed during the last fifteen years. The Maine, Maryland, Georgia, Stout American Industries, Southern Illinois Enterprise, Ohio State, and West Virginia plans stressed the need for students to develop a higher level of abstract understanding of subject matter. Many of these plans advocated the use of concept learning and identified technology as the subject matter of industrial arts.

The need for students to develop a higher level of abstraction in industrial arts can be illustrated by the West Virginia University Industrial Arts Program in the Technologies. The program advocated the use of the concept approach as the means for students to develop abstract understanding of technology.

Technology has been identified by DeVore as a technical-social-cultural phenomenon. This phenomenon has been described as (a) a construct based upon truths that have held constant throughout man's history (Drucker, 1960, 1967; Ellul, 1964); (b) being concerned with the pursuit of effective ways of producing objects and solving problems to sustain life and better meet the needs of life in a specific environment (DeVore, 1970); (c) the study of man's work--his unique means for controlling his physical environment (Drucker, 1960); (d) being artificial--an occurrence which has been created and perpetuated by man (Ellul, 1964); (e) being cumulative in nature; (f) not being neutral, but influenced by the way man behaves in a given socio-cultural environment; and (g) an occurrence which interrelates and interacts within a given socio-cultural environment (Kranzberg & Pursell, 1967).

DeVore (1966, 1967a) has identified that technology meets the criteria of a discipline. Technology is dynamic, cumulative, theoretical, structural, and integrative. The identification of technology as the subject matter of industrial arts would (a) identify a unique body of knowledge, (b) indicate a universal structure and method of inquiry, (c) provide a better means for youth to understand their technical-social-cultural environment, and (d) provide an externally stable and internally flexible industrial arts curriculum (DeVore, 1964, 1966, 1967a, 1967b, 1969a, 1969b).

The study of technology as the subject matter of industrial arts would result in the identification of key ideas, concepts, and principles and their interelationships. The use of the hierarchical organization of technological concepts and principles would allow students to (a) become aware of the structure of technology; (b) learn with greater efficiency; (c) understand meaningful relationships between key ideas, concepts, and principles; and (d) develop productive thinking capabilities. Hence the process of curriculum planning would involve the establishment of (a) a content reservoir, (b) basic concepts and principles, (c) units of instruction based upon the concept learning approach, and (d) courses by grouping units of study (DeVore, 1966).

Purpose of the Study

The purpose of this study was to test guidelines for using the verbal and nonverbal instructional media to help develop an abstract understanding of technical concepts. These identified guidelines could help industrial arts teachers to become more aware of their need to distinguish differences as well as interrelationships between content and instruction.

It was assumed that when industrial arts teachers decided to adopt a recently-developed curriculum plan which emphasized concept learning, they would be faced with a dichotomy between their past instructional procedures and those that were expected of them. The dichotomy could cause teachers to feel a level of frustration and insecurity that would result in them reverting back to their "old techniques." This would cause a deterioration in the normal rate of curriculum transformation.

This predicted deterioration in curriculum transformation was based upon the unconscious nature of the past nonverbal learning experiences of industrial arts teachers. Students who enrolled in industrial arts teacher education programs did so because of their previous success in manual activities. During their professional education experience, they developed competencies in specific technical areas of interest such as wood, metal, drawing, electricity, and graphic arts. These in-depth encounters combined with the lack of meaining identified with their educational theory courses result in "learning by doing" becoming the major criteria for identifying subject matter to be taught as well as the mode of instruction.

The opposite approach would require the teacher to plan his instructional procedures so that students would achieve a higher level of abstract learning. This approach would necessitate that the teacher determine the means for students to move from the concrete to the abstract and to select verbal and/or nonverbal instructional procedures to accomplish this. Thus, content and instruction would have to be treated as separate entities, but interrelated as they relate to the goal to be accomplished.

Hypotheses

Three major hypotheses were identified for testing. Gagné's hierarchy of learning conditions was used to operationally define (a) the verbal instructional medium complementing the nonverbal instructional medium (NV + V_c), (b) the verbal instructional medium (V), and (c) the verbal instructional medium supplementing the nonverbal medium (NV + V_s). Gagné's subordinate hierarchy was used in the NV + V_c and V treatments to structure the intellectual processes needed for students to acquire an abstract understanding of a technical concept.

Gagné's (1965, 1970b) hierarchy of learning conditions consist of signal learning (type 1), stimulus-response learning (type 2), chaining (type 3), verbal association learning (type 4), discrimination learning (type 5), concrete concept learning (type 6), rule learning (type 7), and problem solving (type 8). The first type of learning, signal learning, is not included in the hierarchy of human learning conditions.

The subordinate hierarchy is concerned with the development of cognitive capabilities associated with type 6 and 7 conditions of learning. A review of literature related to the subordinate hierarchy as the relevant variable for developing an abstract understanding of a concept has been included in Chapter 2. (See Figure 3.)

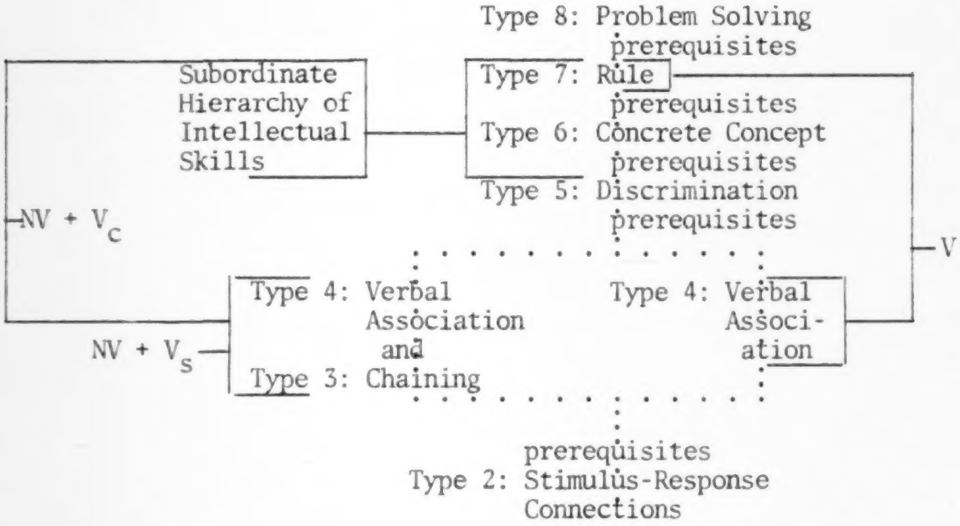

Type 8: Problem Solving
prerequisites
Subordinate Hierarchy of Intellectual Skills
Type 7: Rule
prerequisites
Type 6: Concrete Concept
prerequisites
Type 5: Discrimination
prerequisites
NV + V_c
V
Type 4: Verbal Association and
Type 3: Chaining
NV + V_s
Type 4: Verbal Association
prerequisites
Type 2: Stimulus-Response Connections

Figure 3. A Discription of Gagné's Hierarchy of Human Learning Conditions Used to Operationally Define the NV + V_s, V, and NV + V_c Instructional Media (Gagné, 1970b, p. 66)

The first hypothesis identified was:

> The students' amount of abstract understanding of a pre-selected technical concept taught by the use of the verbal instructional medium complementing the nonverbal instructional medium (NV + V_c) will be greater than the mean level of abstract understanding of students who have been taught by the use of the verbal instructional medium (V) or the verbal instructional medium supplementing the nonverbal instructional medium (NV + V_s).

The NV + V_s instructional medium was operationally defined by chaining and verbal association conditions of learning. Gagné (1970b, pp. 123-131) defined chaining as the combining of individual, previously learned, nonverbal S_s-R connections (links) in proper sequence (a chain) to complete a specific task. Once a chain has accomplished its purpose, the chain does not need to be repeated unless the learner wishes to (a) make sure he knows the sequence of the chain or (b) accomplish the purpose of the chain again. Gagné (1970b, pp. 123-125) has described verbal association as the process of combining previously learned verbal $S \underset{s}{-} R$ links.

Gagné (1970b, pp. 125-126 & 142) denoted the most common way for humans to learn verbal and nonverbal chains involved the use of the second medium to provide external cues for how the verbal or nonverbal chain should be formed.

Chaining and verbal association were used in this study to depict the industrial arts teachers' use of the nonverbal instructional medium to present new content and the verbal instructional medium to describe and/or name the new actions, objects, or events. The verbal description was used to guide the students' nonverbal learning.

Verbal association, discrimination, concrete concept, and rule conditions of learning were used to operationally define the V and $NV + V_c$ instructional media. Discrimination learning, as described by Gagné (1970b, pp. 155-167), involves the learner making the same consistent response to each distinctively different feature of related objects, events, representations, symbols, or space. The learner has achieved this learning condition when he has learned all verbal and nonverbal chains pertaining to a collection of related features. Making consistent responses to relevant stimuli related to a particular collection was described as the means for testing the learner's acquired multiple-discrimination capability.

According to Gagné (1970b, pp. 171-182), concept learning includes concrete concept and rule conditions of learning. Concrete concept learning involves the learner using the same word to describe a class of observable environmental stimuli. The process of generalizing frees the learner's thoughts from the control of environmental stimuli. The learner's acquired capability to make the same response to a class can be determined by evaluating his responses to stimulus situations that were not used during the learning of the concrete concept.

Gagné (1970b, pp. 189-202) has indicated that rule learning involves (a) a higher level of abstraction than concrete concept learning and (b) the use of subordinate hierarchies. Rule learning involves the cognitive process of learners developing an abstract understanding of verbal statements. A verbal statement consists of a relational concept, a sequencing of concrete concepts, or a sequencing of relational and concrete concepts. A relational concept was defined by Gagné as a concept word which is dependent upon a verbal definition to derive its meaning.

Gagné's theory (1970b, pp. 189-202) signified that rules and principles involve verbal statements which have general application to a number of similar, but different situations. Principles consist of previously defined verbal statements which have been identified externally in relationship to the learner. A rule consists of the learner's developed cognitive understanding of a principle or relational concept. His understanding accounts for the regularity of his behavior in a variety of infinitely related situations.

In this report the terms "concrete concept," "technical principle," and "rule" will be used to descriminate between different types of concepts. A technical principle will refer to a technical concept that has been defined externally in relationship to the learner. The students' abstract understanding of a technical principle will be identified as a rule. A specific word that is used to define a technical principle which refers to a class of environmental stimuli will be identified as a concrete concept.

The subordinate hierarchy of intellectual skills (learning sets) was identified by Gagné as the variable which enables students to develop cognitive capabilities. The final task of the hierarchy requires the learner to (a) use verbal knowledge; (b) learn, recall and order intellectual operations; and (c) integrate intellectual operations. All of these elements are internalized in the learners' cognition of a rule. (See Figure 4.)

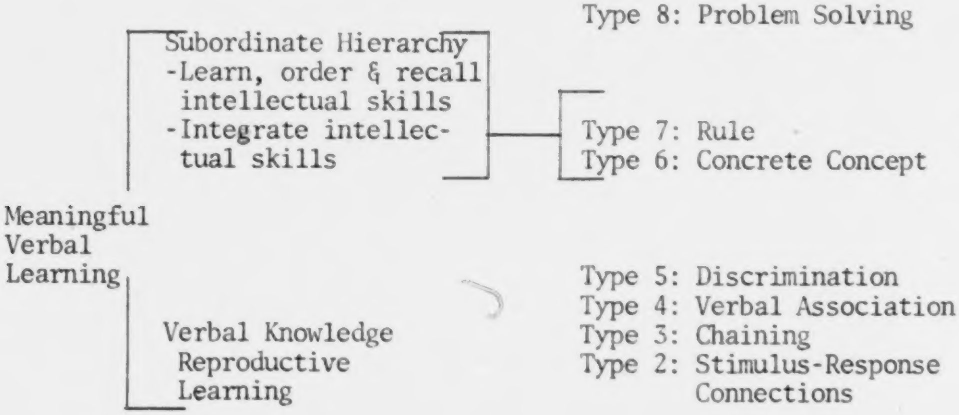

Type 8: Problem Solving
Subordinate Hierarchy
-Learn, order & recall intellectual skills
-Integrate intellectual skills
Type 7: Rule
Type 6: Concrete Concept
Meaningful Verbal Learning
Type 5: Discrimination
Type 4: Verbal Association
Type 3: Chaining
Type 2: Stimulus-Response Connections
Verbal Knowledge Reproductive Learning

Figure 4. The Relationship Between the Subordinate Hierarchy and the Hierarchy of Learning Conditions

Past subordinate hierarchical research has indicated that (a) more than one effective subordinate hierarchy may be developed related to a rule, (b) ineffective hierarchies can be revised, (c) hierarchies don't represent all that can be learned about a given rule, and (d) hierarchies do provide the potential for positive transfer between intellectual skill levels (Gagné, 1968b). Also, subordinate hierarchical research has signified that (a) the lower levels of the subordinate hierarchy provided an effective base for students to achieve higher subordinate levels; (b) the final subordinate task was retained over a long period of time, while lower subordinate tasks were forgotten (Gagné & Basseler, 1963); (c) the superordinate organization of knowledge was a more effective means for the retrieval of information than for the learning of new information (Gagné, 1969a; Gagné and Weigand, 1968, 1970); (d) the subordinate hierarchy reduces individual differences as students progress to higher subordinate hierarchical levels (Gagné, 1962; Gagné, Mayor, Garstens, & Paradise, 1962; Gagné & Paradise, 1961); (e) the subordinate hierarchy can be used to determine each student's intellectual skill level related to a specific final task (Gagné, 1962; Wiegand, 1969); (f) the contextual variety of examples, practice, and time between completing a subordinate hierarchical subtask and starting the next subtask does not affect student performance on the final task (Gagné, Mayor, Garstens, & Paradise, 1962; Gibson, 1969); and (g) a subordinate hierarchy can be used effectively to re-evaluate and restructure learning programs (Gagné & Okey, 1970).

The verbal instructional medium, used to depict the over-verbalization credence, involves verbal association, discrimination, concrete concept, and rule conditions of learning. The nonverbal instructional medium was not used to identify environmental stimuli related to a pre-selected technical principle.

The NV + V_c instructional media incorporated the use of verbal association, discrimination, concrete concept, and rule conditions of learning. The nonverbal instructional medium was used to identify environmental stimuli related to a pre-selected technical principle during verbal association, discrimination, and concrete concept learning.

In summary, Gagné's hierarchy of learning conditions was used to operationally define NV + V_s, V, and NV + V_c instructional media in developing students' abstract understanding of a technical principle. The final subordinate task and transfer task were used to determine the student level of abstract understanding of a pre-selected technological principle.

The second hypothesis identified was:

> On the learning achievement test, it was predicted that the NV + V_S , V, and NV + V_c instructional media treatments would be achieved, each at a higher level than the one preceding.

Testing this hypothesis involved the determination of the learning capability level achieved by the treatment groups.

The third hypothesis identified was:

> The treatment would be a significant factor in the prediction of learning capability scores when combined with IQ, standardized achievement test scores, grades in previous courses, and socio-economic status.

This hypothesis was included because of differences between (a) Gagné's use of programmed instruction versus the use of video tapes, and (b) the purpose of Gagné's subordinate hierarchical research as compared with the purpose of this study.

Gagné's previous subordinate hierarchical research involved the use of written learning programs to determine the effect the subordinate hierarchy had upon learning. The learning programs took two to seven days for the students to complete. In some of the research studies, two learning programs were used. The first program was used to provide the students with the verbal knowledge needed to be able to complete the second program, the latter being organized by the use of a subordinate hierarchy.

Also, previous subordinate hierarchical research which included the use of programmed instruction identified there was a decrease in the relationship between relevant basic ability and performance on the subordinate hierarchy as the learner achieved higher subordinate levels (Gagné, 1962; Gagné, Mayor, Garstens, and Paradise, 1962; Gagné and Paradise, 1961). The results of studies indicated the rate of learning attainment was decreasingly related to relevant basic ability as the learner progressed through the subordinate hierarchical levels. Hence, learning rate attainment was increasingly dependent upon acquired subordinate knowledge (Gagné & Paradise, 1961).

Terminology

Identified below are the definiations of major terms that were used to conduct this study.

1. Human communication was defined as the process of transferring information from one human being to another.

2. Verbal communication was defined as the process of transferring information between human senders and receivers by the use of a language system which used numbers and/or words (Ruesch & Kees, 1961, p. 9).

3. Nonverbal communication was defined as the process of transferring information between human senders and receivers by the use of a "...series of symbols that in their proportions and relations are similar to the thing, idea, or event for which they stand (Ruesch & Kees, 1961, p. 8).

4. A concept was defined as "...some amount of [abstract] meaning more or less organized in an individual's mind as a result of sensory perception of external objects and events and the cognitive interpretation of the perceived data" (Woodruff, 1964, p. 84).

5. Abstract understanding was defined as the learner having acquired verbal cognitive capabilities to internalize and structure rules about the environment by the use of words.

6. Industrial arts was defined as the "...study of man and technology (including the technical and cultural-social elements) as a creative endeavor in meeting the needs of individuals and cultures, in the areas of products, transportation and communication, through utilization of the properties of matter and energy" (DeVore, 1966, p. 11).

7. Technical was defined as "...any portion of the material environment that has been deliberately used, or modified for use, by man" as a means for controlling his physical environment (Bock, 1969, p. 221).

Assumptions

Assumptions made for conducting this research were:

1. That the nonverbal and verbal codification continua exist independent of each other and either medium can be used to supplement or complement the other.
2. That knowledge is cognitively stored in hierarchical order.
3. That verbal learning is the most efficient means for students to acquire an understanding of technical concepts.
4. That most industrial arts teachers are unaware of their use of their past nonverbal learning experiences to determine the subject matter and mode of instruction for industrial arts.
5. That a majority of the students who have enrolled in industrial arts education programs have done so because of previous success in manual activities.
6. That industrial arts teachers should place emphasis on students' abstract understanding of technical principles.
7. That rule learning is defined by the use of Gagné's hierarchy of learning conditions and subordinate hierarchy.
8. That concrete concept and rule conditions of learning free the learner from the control of the environmental stimuli.
9. That a subordinate hierarchy can be constructed so that students will develop abstract understanding of a preselected technical principle.

Limitations

The study was limited to:

1. One randomly sampled county school system.
2. Industrial arts classes at the junior high school level.
3. Biology and mechanical drawing classes at the senior high school level.
4. Abstract learning of technical principles.
5. A technical principle that depicted the criteria for both the NV + V_c and NV + V_s lessons.
6. Technical principles to which students had not been exposed.
7. The researcher's lack of knowledge about the students' previous nonverbal learning experiences related to the technical principle selected for conducting the study.
8. The use of one technical principle to test the hypothesis that NV + V_c is the best guideline.
9. Three instructional guidelines as tested by the NV + V_c, V, and NV + V_s treatments.
10. The use of Gagné's hierarchy of learning conditions to operationally define the nature of the NV + V_c, V, and NV + V_s lessons.
11. The use of Gagné's subordinate hierarchy to operationally define instruction for sutdents to acquire an understanding of a rule.
12. A formal, structured classroom presentation.
13. The presentation being presented in one class period (45 minutes).
14. The use of video tape to present the NV + V_c, V, and NV + V_s lessons.
15. The use of one video tape each to present the NV + V_c, V, and NV + V_s lessons.
16. The final and transfer task tests which were assumed to measure abstract learning.

CHAPTER II

REVIEW OF RESEARCH AND RELATED LITERATURE: GAGNÉ'S SUBORDINATE HIERARCHY

The three treatments tested for determining instructional guidelines were operationally defined by the use of Gagné's hierarchy of learning conditions and subordinate hierarchy. The hierarchy of learning conditions was used to circumscribe the role of the nonverbal and verbal media per treatment and to predict the level of learning the students were expected to achieve per treatment. The $NV + V_c$ and V treatments were directly concerned with the identification of instructional guidelines related to abstract learning. The $NV + V_s$ treatment was concerned with determining whether students developed an abstract understanding of technical principles as the result of having been shown how to complete an operation.

The subordinate hierarchy was used to plan the $NV + V_c$ and V instructional procedures. The hierarchy has been identified by Gagné as the critical variable concerned with the external organization of intellectual operations (instruction). The organization of these operations provides the means for students to develop cognitive capabilities. These capabilities result in them being able to acquire an abstract understanding of concepts and principles (Gagné, 1965, 1970b, 1971). The latter have been identified by Gagné as type 6 and 7 conditions of learning (Gagné, 1965, 1970b).

This chapter has been devoted to a detailed review of Gagné and associates' subordinate hierarchical and superordinate research. The superordinate review was included to identify the role "organizers" have on cueing recall or contextual learning materials. This research has helped to identify similarities and differences between Ausubel's and Gagné's cognitive theories.

The same procedure was used to review both the subordinate and superordinate research. The introduction of each section summarized the research findings. Next, each study was reviewed. The first paragraph of each review identified the major research findings. The following paragraph described the theory, purpose, and/or hypothesis tested. The remaining paragraphs examined the procedure used to conduct the study.

The review was organized in this manner since no complete summary of Gagné's subordinate and superordinate research had been compiled. In 1970, Gagné (1970a) reviewed some of the later studies. This review did not include the early research studies which laid the foundation for later hierarchical research.

The subordinate hierarchical research has been identified as the bases for Gagné's (a) cumulative learning paradigm (Gagné, 1968a); (b) process approach in science (A. A. A. S., 1965, 1968); and (c) reconceptualization of learning as information processing (Gagné, 1970d).

The third section of this chapter was devoted to a discussion of how the research findings were used to conduct this study.

Subordinate Organization of Intellectual Operations

The 14 studies reviewed were concerned with the subordinate and superordinate organization of intellectual operations. The findings of the 11 subordinate hierarchical studies found (a) that the subordinate organization of intellectual operations affected student performances on the final and transfer tasks (Gagné & Brown, 1961; Gagné, 1962; Gagné & Paradise, 1961; Gagné, Mayor, Garstens, & Paradise, 1962, Gagné & staff, 1963; Gagné & Bassler, 1963; Wiegand, 1969; Coleman, 1969; Gagné & Okey, 1970); (b) that the completion of the next highest subordinate level was dependent upon the accomplishment of the lower adjacent subordinate level (Gagné, 1962; Gagné & Paradise, 1961; Gagné, Mayor, Garstens, & Paradise, 1962; Gagné & staff, 1963; Wiegand, 1969; Gagné & Okey, 1970; (c) that the completion of higher adjacent subordinate levels reduced individual differences related to the final task (Gagné, 1962; Gagné & Paradise, 1961; Gagné, Mayor, Garstens, & Paradise, 1962); (d) that verbalization during problem solving situations affected student capability to solve problems (Gagné & Smith, 1962); (e) that the subordinate hierarchy was effective in determining a student's level of capability related to the final subordinate task (Gagné, 1962; Wiegand, 1969); (f) that guidance, repetition, and overlearning did not affect student capabilities to complete the final and transfer tasks; (g) that the interaction of high guidance and high repetition did have an effect on student capabilities to complete the final and transfer tasks (Gagné, Mayor, Garstens, & Paradise, 1962; Gibson, 1969); (h) that lower subordinate knowledge was not retained over a nine-week period, whereas, the ability to do the final task was retained (Gagné & Bassler, 1963); (i) that the use of a subordinate learning set re-test had a significant effect on student capability to complete the final task (Wiegand, 1969); (j) that the use of the process approach in social science was dependent upon a hierarchy of intellectual skills (Coleman, 1969); and (k) that the hierarchy was used effectively to restructure a science instructional learning program (Gagné & Okey, 1970). From comments made in the text, footnotes, and bibliographical entries, the researcher assumed that Gagné's 1962 study was done prior to Gagné and Paradise's 1961 and Gagné, Mayor, Garstens, and Paradise's 1962 studies. Also, many of the earlier studies were conducted as part of the University of Maryland's Mathematics Project.

Gagné and Brown (1961)

The findings of this research indicated that what was learned while students completed a learning program to teach rules had a significant effect on their ability to solve contextually related problems.

The purpose of Gagné and Brown's study was to identify learning program variables which had an effect on student understanding of concepts. The program learning variables manipulated were step-wise versus abrupt sequencing and types of discovery statements versus verbal statements with examples. A review of previous research by

Katona, Skinner, and others was used to designate program learning variables and ways of measuring student understanding of concepts.

The materials used to conduct this study consisted of an introductory learning program, three experimental programs, and a problem-solving test. The introductory program, which all subjects had to complete, explained basic knowledge related to number series. The discovery, guided discovery, and rule with example programs were designed to develop student understanding of rules used for deriving formulas to explain a number series. The discovery program consisted of abrupt sequencing and the identification of rules that applied to each step for deriving a number series formula. The number of hint cards used by the subjects to make a response was counted. The guided discovery program consisted of small sequencing steps. Questions were used to guide the learning of the rule. Verbal statements of rules with examples were used to construct the rule and example program.

The problem-solving test measured the amount of application of rules to novel, contextually related problem solving situations. The time and number of hints used to solve the problems and the number of incorrect answers were recorded.

The subjects were 33 ninth and tenth grade boys enrolled in a general mathematics class. The subjects either had previously completed an algebra course or were presently enrolled in one. After the subjects had completed the introductory program, they were randomly assigned to one of the three experimental groups.

The subjects were required to complete their assigned experimental programs twice, once a day for two consecutive days. On the fourth day the problem-solving test was administered.

The Bartlett's, analysis of variance, and "t" tests were used to analyze the data. The guided discovery program was found to be significantly different from the rule and example program. The guided discovery and discovery programs were not found to be significantly different. The order of the weighted time-hint problem solving means for the three treatments were: guided discovery, discovery, and rule with example (22.6, 28.4, and 46.8, respectively).

Gagné and Brown concluded that, irrespective of how the material had been presented, what was learned and not how it was learned was the critical variable that affected transfer. The subjects assigned to the guided discovery program were required to state, in writing, the rule they used to answer each question. The discovery program required that the students analyze incorrect answers and identify the correct answers after hints were provided. The authors concluded that the results did not identify specific factors which had an effect on transfer.

Gagné (1962)

This research identified (a) that the prerequisiting of intellectual operations enabled students to complete a specified final subordinate task; (b) that students who did not complete the lower subordinate operations were unable to complete the final subordinate task; (c) that once students were able to successfully complete the subordinate levels missed, they were able to complete the final subordinate task; and (d) that the subordinate hierarchy could be used to determine the student's pattern of capability related to the final task.

The theory tested was described by Gagné as follows:

> A human learner begins the acquisition of the capability of performing a particular class of tasks with an individual array of relevant learning sets, previously acquired. He than acquires new learning sets at progressively higher levels of knowledge hierarchy until the final class of tasks is achieved. Attaining each new learning set depends upon a process of positive transfer, which is dependent upon (a) the recall of relevant subordinate learning sets, and upon (b) the effects of instructions (Gagné, 1962, p. 358).

The hypotheses tested were (a) the learner would not be able to complete the final task unless he had acquired the prerequisited intellectual operations, and (b) a learner could complete any superordinate task in the subordinate hierarchy provided the lower subordinate operations could be recalled and proper instructions were given.

The rationale for the above theory was based upon an analysis of previous program learning research by Lumsdaine and Glaser; Hilgard, Irvine, and Whipple; Katona; and Maltzman, Eisman, Books, and Smith. Gagné identified that the above research created an interest in auto-instructional devices, not because of the technological innovativeness, but because they provided a means for studying productive learning. Productive learning was defined as a

"...change in human behavior which permits the individual to perform successfully on an entire class of specific tasks, rather than simply on one member of the class" (Gagné, 1962, p. 355).

The information acquired as the result of successfully completing a learning program was designated as knowledge. Knowledge was defined as "...the inferred capability which makes possible the successful performance of a class of tasks that could not be performed before the learning was undertaken" (Gagné, 1962, p. 355).

Gagné operationally defined knowledge as it related to program instruction. He dichotomized knowledge into two variables: knowledge and instruction. Knowledge, in this case, was defined as the "...capabilities the individual possesses at any given stage in the learning program" (Gagné, 1962, p. 355). Instructions were defined as "...the content of the communications presented within the frames of a learning program" (Gagné, 1962, p. 356). The four major purposes of instruction in a learning program were to (a) identify the terminal response required of the learner, (b) identify elements of the stimulus situation, (c) require the learner to recall past learning sets, and (d) provide guidance for thinking (Gagné, 1962, pp. 357-358).

The means Gagné described for developing a subordinate hierarchy of knowledge consisted of asking two questions. The first question was about the final task. The question was concerned with finding formulas for sum of "n" terms in a number series. The question asked was: "What kind of capability would an individual have to possess if he were able to perform this task successfully, were we to give him only instructions?" (Gagné, 1962, p. 356). After identifying a class of tasks related to the original final task, the second question was asked of each of the classes. The question was: "What would the individual have to know in order to be capable of doing this task without undertaking any learning, but given only some instructions?" (Gagné, 1962, p. 356). The final subordinate hierarchy included four levels. (See Figure 5.)

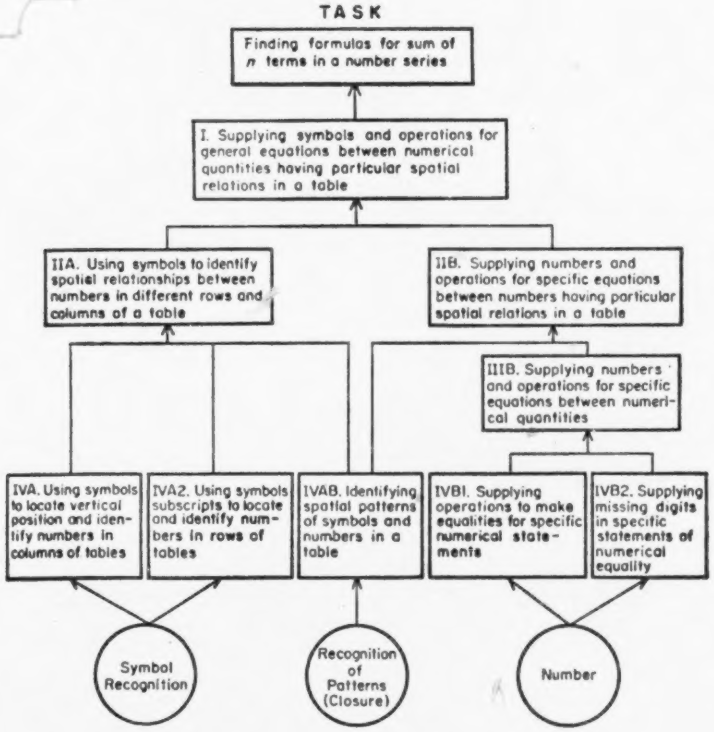

TASK
Finding formulas for sum of n terms in a number series
I. Supplying symbols and operations for general equations between numerical quantities having particular spatial relations in a table
IIA. Using symbols to identify spatial relationships between numbers in different rows and columns of a table
IIB. Supplying numbers and operations for specific equations between numbers having particular spatial relations in a table
IIIB. Supplying numbers and operations for specific equations between numerical quantities
IVA. Using symbols to locate vertical position and identify numbers in columns of tables
IVA2. Using symbols subscripts to locate and identify numbers in rows of tables
IVAB. Identifying spatial patterns of symbols and numbers in a table
IVB1. Supplying operations to make equalities for specific numerical statements
IVB2. Supplying missing digits in specific statements of numerical equality
Symbol Recognition
Recognition of Patterns (Closure)
Number

Figure 5. Subordinate Hierarchy of Intellectual Operations for Finding Formulas for Sum of "n" Terms in a Number Series (Gagné, 1962, p. 359)

The materials used to conduct the research consisted of a learning program and a learning set test based upon the developed subordinate hierarchy. The learning set test included a test item per hierarchical level. Following the final subordinate task test item, the rest of the items were arranged from the highest to the lowest subordinate level. The test instructions identified the terminal response expected and the important elements of the stimulus situation. The procedure used to collect the data consisted of individually administering the learning set test to 7 ninth grade boys.

When the subject was able to answer a test item correctly, he was required to complete the learning program. The program was started at the last subordinate hierarchical level the student missed on the test. The learning program included instructions that (a) required him to recall lower relevant learning sets, (b) identified the terminal response expected of him, and (c) guided the learner's thinking. After the completion of the program, each subject was administered the same learning set test. The subjects were required to complete the lower subordinate level items that they had not been exposed to during the first testing situation. Gagné denoted that giving the same test twice caused the subjects to become familiar with the test the second time.

The analysis of data from the test administered the first time indicated that there were differences in the student "patterns of capability" in completing the final task. All students were not able to complete the final task. (See Table 1.)

Table 1. Pattern of Success on Learning Set Tasks Related to the Final Number Series Task for 7 Ninth Grade Boys (Gagné, 1962, p. 360)

Subject	Task									
	Final	I	IIA	IIB	IIIB	IVA1	IVA2	IVAB	IVB1	IVB2
1	– *	+**	+	+	+	+	+	+	+	+
2	–	+	+	+	+	+	+	+	+	+
3	–	–	–	+	+	+	+	+	+	+
4	–	–	–	+	+	+	+	+	+	+
5	–	–	–	–	+	+	+	+	+	+
6	–	–	–	–	–	+	+	+	+	+
7	–	–	–	–	–	+	+	+	+	+

* – means that the subject failed the task.

** + means that the subject passed the task.

The analysis of the data from the second administration of the learning set test determined that positive transfer took place. (See Table 2.) Positive transfer was expected to take place between (a) the final task and level I, (b) level I and the subordinate level consisting of superordinate tasks IIA and IIB, (c) level IIA and the subordinate level consisting of tasks IVA1, IVA2, IVAB, (d) level IIB and IIIB, and (e) level IIIB and subordinate level consisting of tasks IVAB, IVB1, and IVB2.

Table 2. Pass-Fail Relationship Between Related Adjacent Higher- and Lower-Level Learning Sets for a Group of 7 Ninth Grade Boys (Gagné, 1962, p. 361)

Relationship examined	Number of cases with relationship				Test of relationships	
	Higher + Lower +	Higher – Lower –	Higher + Lower –	Higher – Lower +	N (1 + 2 + 3)	Proportion (1 + 2)/(1 + 2 + 3)
Final Task: I	0	6	0	1	6	1.00
I: IIA,IIB	1	5	0	1	6	1.00
IIA: IVA1,IVA2,IVAB	2	0	0	5	2	1.00
IIB: IIIB	3	2	0	2	5	1.00
IIB: IVAB,IVB1,IVB2	5	0	0	2	5	1.00

A positive transfer index was determined by adding the number of ++, and -- patterns and dividing them by the number of ++, --, and +- patterns. The pattern of results between each adjacent subordinate level was determined by using the following criteria:

1. If a higher-level learning set is passed (+), all related lower-level tasks must have been passed (+).
2. If one or more lower-level tasks have been failed (-), the related higher-level tasks must be failed (-).
3. If a higher-level task is passed (+), no related lower-level tasks must have been failed (-).
4. If a higher-level task has been failed (-), related lower-level tasks may have been passed (+) (Gagné, 1962, pp. 360-361).

The absence of positive transfer for criteria number four was attributed to a deficiency in the instructions, "...and does not contradict the notion that lower-level sets are essential to the achievement of higher-level ones" (Gagné, 1962, p. 361). The positive transfer index was 1.00 in all instances.

The effect the learning program had on student capability to do the final task was determined by a second means. Eighteen out of twenty-one hierarchical levels were failed when the test was administered the first time. The percentages of success among pre- and post-hierarchical level test results were 86% for the final task, 80% for level I, 100% for level II, 50% for level IIB, 100% for level IIIB, and 86% for all instances combined. Six out of seven students were able to do the final task after completing the learning program.

Gagné concluded that the research findings supported the hypotheses tested. The findings indicated that the students functioned at different subordinate capabilities before receiving instruction and the subordinate hierarchy enabled the students to successfully complete the final task. Gagné speculated that the students' individual differences related to a specific final task were reduced as the result of organizing material in a subordinate hierarchical manner.

Gagné and Paradise (1961)

The findings of this study identified (a) that the completion of the lower subordinate levels enabled students to execute the final task, (b) that the completion of each successive higher level learning set was dependent upon the mastery of the adjacent lower-level learning set, and (c) that the progressive achievement of higher subordinate levels reduced differences among individuals related to the final subordinate task.

The theory tested was that the rate of attainment of subordinate learning sets becomes increasingly dependent upon the learning sets previously achieved and decreasingly dependent upon IQ and basic abilities. The hypotheses tested were (a) that the development of abilities relevant to a subordinate hierarchy mediate positive transfer and an increase in the rate of learning, (b) that the relationship between basic ability and rate of learning set attainment decreases as students achieve higher subordinate levels, (c) that the relationship between general intelligence and rate of subordinate attainment remains the same as students achieve higher subordinate levels, and (d) that the relationship between irrelevant basic abilities and rate of attainment remains the same as students achieve higher subordinate levels.

The procedure used for conducting the study consisted of developing a subordinate hierarchy, constructing a learning program, constructing tests to measure student performances, collecting data, and analyzing the data. The same basic procedure used by Gagné in his 1962 study was employed to develop the subordinate hierarchy. A change in the procedure involved asking one question about the final task and the same question about each new class of tasks identified. The question asked was: "What would an individual have to know how to do in order to achieve successful performance on this (new) task, when given only instructions?" (Gagné & Paradise, 1961, p. 4).

Gagné further noted (a) that more than one hierarchy could be developed related to a specific final task, (b) that one hierarchy may be more effective than another, (c) that the effectiveness of a hierarchy is determined by positive transfer, and (d) that each hierarchical level requires the learner to recall, order, and integrate lower subordinate learning sets.

The subordinate hierarchy was used by Gagné and Paradise to construct a learning program and three tests. The final task test consisted of the final task of the subordinate hierarchy. The program learning material was designed to prepare the students to complete the final task, but did not include the task. The transfer test included equations which differed in form and symbols, but were contextually related to the final task. A learning set test was developed to measure learning level achievement. The test items were organized from the lowest to highest subordinate level, but did not include the final task.

The subjects consisted of seventh grade students enrolled in mathematics classes in two schools. The classes sampled were of intermediate ability and heterogenously grouped.

The procedure for collecting the data consisted of giving standardized tests that were considered relevant and irrelevant to mathematics. On the second through the ninth school days the learning program was administered. The program consisted of 247 frames which were divided into eight booklets. Every three minutes the students were required to place a mark in their program book. This was used to measure the rate of attainment. On the tenth day the performance (final task) and transfer tests were administered. The program achievement (learning set) test was administered on the last day.

The data were analyzed to determine if positive transfer occurred and the relationships among relevant and irrelevant basic abilities with IQ and rate of attainment. The mean performance of the students on the transfer test indicated that the learning program was moderately low in its effectiveness.

The positive transfer indexes ranged from .91 through 1.00, as determined from the learning set test. The learning set test was scored in the manner used by Gagné in his 1962 study.

Rate of attainment was used to give some indication of successful performance on the learning program and tests. The students who completed the largest number of learning sets did well on the final and transfer task tests. Also, they took the least amount of time to complete the learning program.

Product moment correlations were computed to determine the relationship of relevant and irrelevant basic abilities with rates of attainment and performance on the final, transfer, and learning set tests. Moderately high correlations were found to exist among the subordinate learning test performances and number, symbol recognition, and mathematical integration abilities. The latter were identified as relevant basic abilities. The correlation between vocabulary, an irrelevant basic ability, and performance on the subordinate learning test was low. A moderately high correlation was computed between speed of symbol discrimination, an irrelevant ability, and performance on the learning set test. The fairly high intercorrelations among the four subordinate performance measurements indicated that they were measuring the same capability.

Patterns of correlations were determined among relevant and irrelevant basic abilities with the rate of attainment. The patterns confirmed that the "...rate of learning depends decreasingly upon relevant abilities as learning progresses upwards in the hierarchy" (Gagné & Paradise, 1961, p. 13). The correlation between basic ability and rate of attainment was high at the lower subordinate level, but decreased as higher levels were achieved. The correlation patterns between irrelevant basic abilities and rate of attainment was low and held relatively constant as higher subordinate levels were achieved (Gagné & Paradise, 1961, p. 13).

The unexpected increase in the pattern of correlations between learning set achievement and relevant ability was assumed to have resulted from the ineffectiveness of the learning program. As individuals achieved higher subordinate levels, more of them "dropped out." The correlation pattern between IQ and rate of attainment remained the same as students achieved higher subordinate levels.

Gagné and Paradise concluded that the significant correlations ($\alpha = .01$) between relevant and irrelevant paired subordinate tasks at the higher subordinate levels, as compared with the insignificant ($\alpha = .10$) relationships between relevant and irrelevant paired subordinate tasks at the lower subordinate levels, combined with the decrease in correlation patterns between basic abilities and rate of attainment, indicated that each adjacent learning set became increasingly dependent upon knowledge acquired from lower adjacent learning sets as the student progressed up the subordinate hierarchy. Thus, the subordinate hierarchy reduced individual differences related to the final task as they achieved higher subordinate levels.

Gagné, Mayor, Garstens, and Paradise (1962)

The results of this study identified (a) that the subordinate hierarchy was a critical variable which affected performances on the final and transfer tasks, (b) that past performances in the area of mathematics did not have an effect on performances on the final or transfer mathematical tasks, and (c) that the effectiveness of repetition and guidance in a learning program, except when combined, did not have a significant effect on performances on the final and transfer tasks.

The purpose of this study was to determine the effect the subordinate hierarchy, recallability, and integration had on student capabilities to "transfer a learning structure" to novel, contextually-related problem-solving situations. This study was based upon further need to test the subordinate hierarchical theory of learning. The theory was summarized in this study as follows:

> ...a class of human tasks to be learned (like solving linear equations, adding rational numbers) can be analyzed into a hierarchy of subordinate learning sets, which mediate positive transfer of learning in a unidirectional fashion from one to another, and ultimately to the final performance task. Such an analysis is executed by asking...the previously identified question of the final task and each class of tasks identified, ...until one describes a "hierarchy of knowledge" containing very simple and general learning sets at its lowest level,
>
> Besides differences in basic abilities, the theory affirms that learners begin a particular learning program (or other productive learning situations) with differing patterns of subordinate learning sets. If the learning program is successful, it insures positive transfer from

> lower level to higher level learning sets for each individual learner, and thereby reduces individual differences in achievement of all subordinate learning sets in the hierarchy, as well as of the final class of tasks. (Gagné, Mayor, Garstens, & Paradise, 1962, p. 1).

Positive transfer was identified as the primary function of a learning program.

The final task selected for conducting this study was adding integers. An analysis of this task resulted in the identification of two final tasks: (a) the formulation of a definition for the addition of integers and (b) the process of adding integers. (See Figure 6.)

Four learning programs were used to vary recallability and integration. Recallability was defined as the use of recognition and/or repetition frames to remind the learner of past knowledge he had already acquired. Integration was defined as the use of frames which required the learner to put together previously learned subordinate learning sets. Integration frames were used to guide the learner's thinking.

The four learning programs were: low repetition, low guidance; low repetition, high guidance; high repetition, low guidance; and high repetition, high guidance. Low repetition used one or two problems per subordinate level. High repetition included the use of four to five or eight to ten problems per subordinate level. Low guidance involved the use of one frame to illustrate the thinking procedure for integrating knowledge. The use of several frames was defined as high guidance.

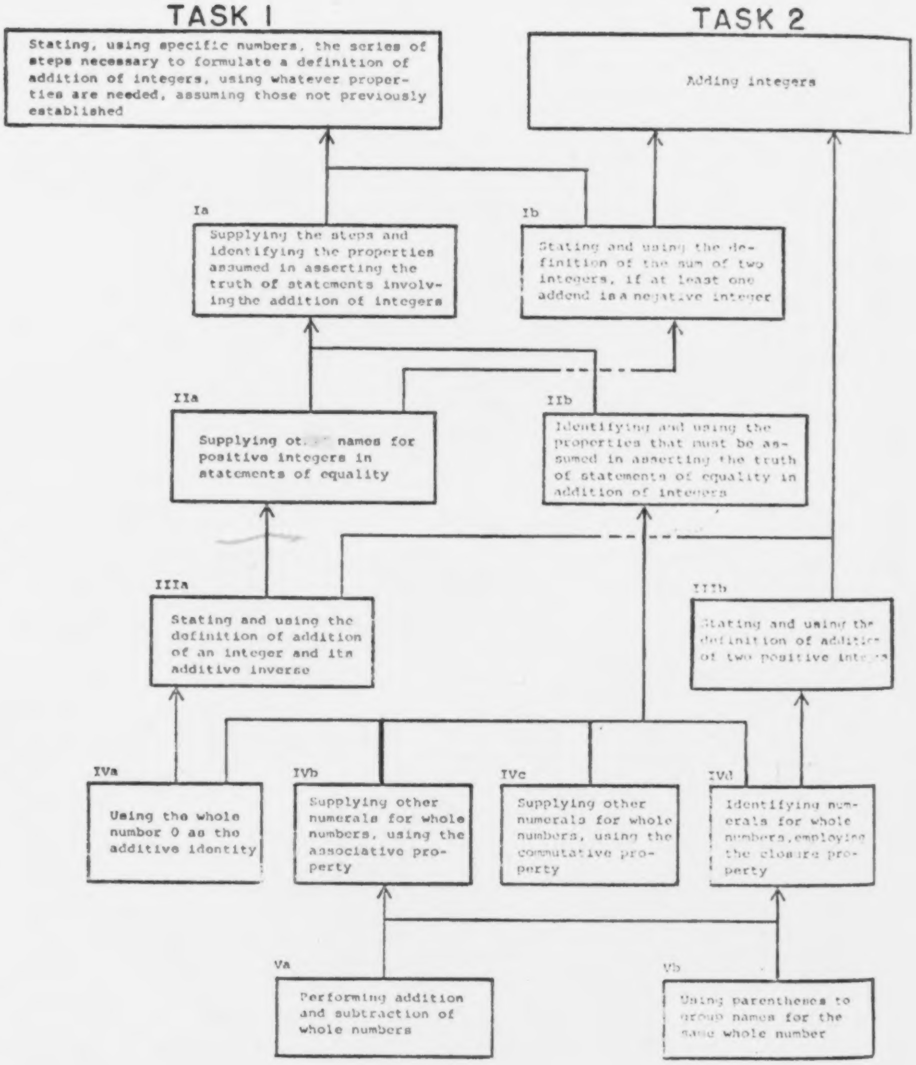

TASK 1
Stating, using specific numbers, the series of steps necessary to formulate a definition of addition of integers, using whatever properties are needed, assuming those not previously established
TASK 2
Adding integers
Ia
Supplying the steps and identifying the properties assumed in asserting the truth of statements involving the addition of integers
Ib
Stating and using the definition of the sum of two integers, if at least one addend is a negative integer
IIa
Supplying other names for positive integers in statements of equality
IIb
Identifying and using the properties that must be assumed in asserting the truth of statements of equality in addition of integers
IIIa
Stating and using the definition of addition of an integer and its additive inverse
IIIb
Stating and using the definition of addition of two positive integers
IVa
Using the whole number 0 as the additive identity
IVb
Supplying other numerals for whole numbers, using the associative property
IVc
Supplying other numerals for whole numbers, using the commutative property
IVd
Identifying numerals for whole numbers, employing the closure property
Va
Performing addition and subtraction of whole numbers
Vb
Using parentheses to group names for the same whole number

Figure 6. Hierarchy of Knowledge for Adding Integers (Gagné, Mayor, Garstens, & Paradise, 1962, p. 4)

Performance (final task), transfer, and learning set tests were constructed to measure student performances. The performance test consisted of final tasks 1 and 2. The transfer test measured the application of principles learned to new contextually-related problem-solving situations. The amount of positive transfer was determined by the learning set test.

The subjects were 136 seventh grade students enrolled in four general mathematics classes. Past mathematics grades were used to randomly assign students to high and low ability subgroups for each of the four treatment groups. Learning programs per treatment were administered one period a day for four consecutive days. On the fifth day the performance (final task) test was administered. The transfer and achievement tests were administered on the sixth and seventh days.

An analysis of the data indicated (a) that positive transfer indexes ranged between .97 through 1.00, (b) that the learning program was not very effective in preparing students for completing final task 1 (definition of the process for adding integers), but was effective for task 2 (adding integers), (c) that the knowledge acquired from the completion of final task 2 (adding) affected student performances on the transfer test for task 2, whereas, the knowledge acquired from the completion of task 1 (definition) was not readily transferable to related problem solving situations used for task 1, (d) that the correlations between past mathematics grades with performances on final tasks 1 and 2 and the transfer task were very low, (e) that the correlations among the number of learning sets achieved and performances on the final and transfer tasks were high, (f) that final task 1 (definition) required better integration of the knowledge from previous learning sets than did task 2 (adding), (g) that performances on task Ia had a significant effect on the accomplishment of final task 1 (definition) and contributed significantly, but less effectively to the accomplishment of task 2 (addition), (h) that variations in either repetition or guidance did not have a significant effect on performances on the final and transfer tasks, (i) that high repetition, high guidance had a significant effect on performances on task 1 (definition) when compared with the low repetition, low guidance treatment, and (j) that high or low mathematics ability did not have a significant effect on performances on the final transfer tasks.

The effect mediation, associated with a lower adjacent task, had on a higher level task was determined by comparing the test results of the next lowest adjacent level to the level being studied with the next highest adjacent level. The amount of successful mediation was found to be significant when compared with the amount of unsuccessful mediation.

Gagné, Mayor, Garstens, and Paradise concluded (a) that the successful accomplishment of a subordinate learning set was dependent upon the successful completion of lower adjacent subordinate sets, (b) that students who were able to do the final tasks had successfully completed the lower subordinate tasks, (c) that the lower subordinate levels functioned as mediators for higher subordinate levels, (d) that repetition or guidance did not have a significant effect on student capabilities to complete the final and transfer tasks, (e) that past mathematics grades did not have an effect on student capabilities to complete the final and transfer tasks, and (f) that the accomplishment of task Ia had an effect on the accomplishment of final tasks 1 and 2. The combined effect of high repetition and high guidance was thought to have resulted from recall frames identifying knowledge to be used during the guidance of the learner's thinking.

Gagné and Smith (1962)

This study identified that verbalization had an effect on student abilities to solve problems.

The need for this study was based upon conflicting research findings concerned with the effect verbalization of a principle had on problem solving. Katona, Hendrix, Haslerud and Myers, and Corman identified that verbal instructions did not have an effect on the transfer of principles to related problem-solving situations. Evert and Lambert signified that principles stated verbally affected student abilities to solve problems. Gagné and Brown (1961) identified that what was actually learned had an effect on transfer.

Variations of the disc problem used by Evert and Lambert were used to conduct this study. The discs, graduated from large to small, were stacked in one pile. The problem was to transfer the stack to a second pile by moving one disc at a time. During the transfer process, no larger disc could be placed on a smaller disc. Discs could be moved to one intervening position. The second stack of discs had to be in the same order as the original stack. The lowest number of moves possible were 2n - 1, "n" equaling the number of discs in the original stack. Having an odd or even number of discs in the original stack determined how the process was to be started.

The subjects involved in the study were 28 boys who volunteered, each having at least an IQ of 110. Each subject, individually, was shown the equipment for the disc problem. The subjects were given instructions and informed of the minimal number of moves possible. Each subject was required to do the three- and four-disc problems to completion. The number of moves per subject was recorded.

Next, the subjects were randomly assigned to one of four treatments. The V-SS treatment required the students to state each move they were going to make and to try to develop a general rule for solving the problem. The subjects in the V treatment were required to state each move, but were not informed about developing a rule. The subjects assigned to the SS treatment were not required to verbalize each move, but were instructed to develop a general rule. The control group was not required to verbalize each move nor develop a general rule. The number of moves per disc problem was recorded. The meaning of the statements was recorded for the treatments requiring subjects to verbalize their moves.

Each subject was required to do a six-disc problem after he completed the two-, three-, four, and five-disc problems. During this testing situation, the subjects were not required to verbalize their moves. The time it took to complete the problem and the number of moves were recorded. At the end of the test, each subject was required to verbally state the principle he had applied.

The principle statements made by the subjects at the end of the six-disc problem were classified as being inadequate, partial, or complete by two experimenters working independently of each other. The application of the Fisher exact probability test indicated (a) that the control group did significantly poorer than those treatments which required the subjects to verbally predict each move, (b) that the treatments which required students to develop rules did significantly better than those which did not, and (c) the V-SS treatment group did significantly better than the SS or NO treatment groups.

The results of the study denoted (a) that there were no significant differences among the four treatment groups on the initial three- and four-disc problems; (b) that verbalization had an increasing effect on the solution of the three-, four-, and five-disc problems; and (c) that verbalization had a significant effect on the student capabilities to solve the six-disc problem.

Gagné and Smith concluded that verbalization during practice accounted for differences among student performances on the six-disc problem. Verbalization forced the students to acquire an understanding of the principle required to solve the disc problems.

Gagné and staff (1963)

This study identified that the attainment of a subordinate level of knowledge was dependent upon acquiring the lower, adjacent level. Also, time and variety of examples in a learning program did not have a significant effect on productive learning.

This study was designed to determine the effect the following variables had on productive learning: (a) contextual variety in problem-solving situations, (b) time lapse between subordinate levels and the completion of example problems, and (c) ordering of subordinate topics. The rationale for including these three research variables was (a) that each subordinate level would identify topical organization as a major factor which would affect productive learning, (b) that the use of a variety of examples would enhance recallability, (c) that the use of learning programs which repeated examples would be better than programs that contained no examples, and (d) that the number of examples would give the learner more time to acquire knowledge.

The procedure previously described in Gagné and Paradise's study was used to develop the subordinate hierarchy. The final task identified was specifying sets, intersections of sets, and separation of sets using points, lines and curves. (See Figure 7.) The subordinate hierarchy was used to construct a basic learning program. Learning frames per subordinate hierarchical level (a) identified the format of the response expected of the learner, (b) identified new symbols, (c) provided a means for the learner to

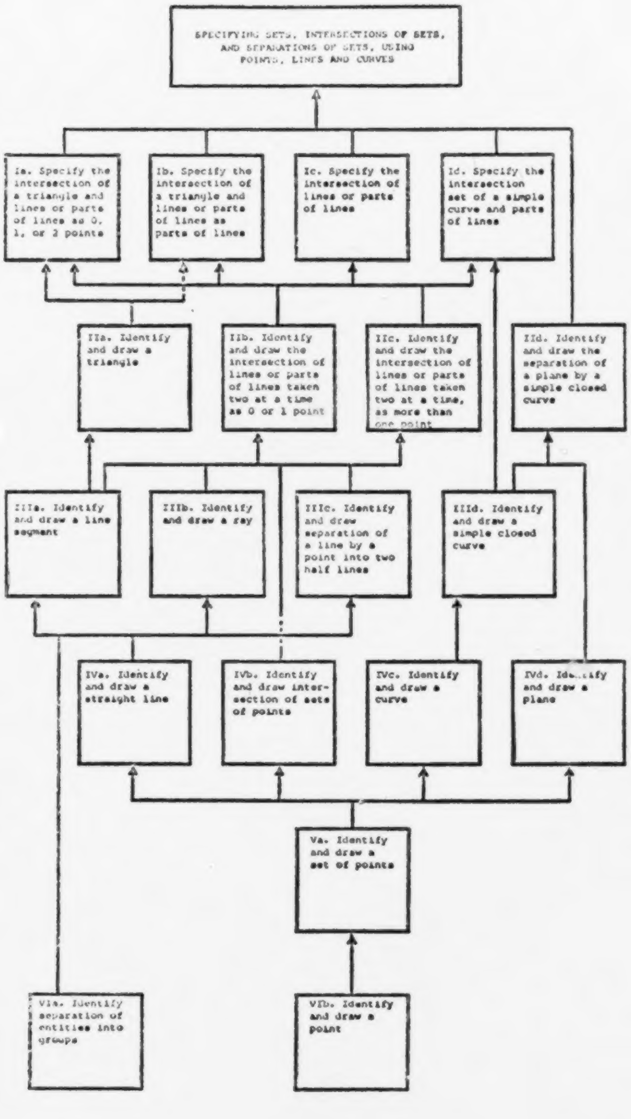

SPECIFYING SETS, INTERSECTIONS OF SETS, AND SEPARATIONS OF SETS, USING POINTS, LINES AND CURVES
Ia. Specify the intersection of a triangle and lines or parts of lines as 0, 1, or 2 points
Ib. Specify the intersection of a triangle and lines or parts of lines as parts of lines
Ic. Specify the intersection of lines or parts of lines
Id. Specify the intersection set of a simple curve and parts of lines
IIa. Identify and draw a triangle
IIb. Identify and draw the intersection of lines or parts of lines taken two at a time as 0 or 1 point
IIc. Identify and draw the intersection of lines or parts of lines taken two at a time, as more than one point
IId. Identify and draw the separation of a plane by a simple closed curve
IIIa. Identify and draw a line segment
IIIb. Identify and draw a ray
IIIc. Identify and draw separation of a line by a point into two half lines
IIId. Identify and draw a simple closed curve
IVa. Identify and draw a straight line
IVb. Identify and draw intersection of sets of points
IVc. Identify and draw a curve
IVd. Identify and draw a plane
Va. Identify and draw a set of points
VIa. Identify separation of entities into groups
VIb. Identify and draw a point

Figure 7. Subordinate Hierarchy for the Final Task of Specifying Sets, Intersections of Sets, and Separations of Sets, Using Points, Lines, and Curves (Gagné and staff, 1963, p. 44)

recall relevant subordinate knowledge, (d) provided a means for guiding the learner's thinking, and (e) required the learner to reply to problem examples. Also, the learning frames were used to repeat problem examples at different subordinate hierarchical levels.

The basic learning program was used to devise five experimental treatment programs. The programs were as follows:

E1 - Minimal contextual variety of examples

E2 - Intermediate contextual variety of examples

E3 - Maximum contextual variety of examples

E0 - Basic learning program with no additional frames

EA - Basic learning program with irrelevant arithmetic problems

The irrelevant arithmetic problems were added so that the program would take the same amount of time as E1, E2, and E3 programs.

A performance (final task) test and subordinate knowledge (learning set) test were developed to measure student performances. The performance test included a variety of problems related to the final task. A total of 31 points was possible. The learning set test included cne item for each contextual program learning example level per hierarchical level. A pass or fail score was assigned to each contextual level test item per subordinate level.

The subjects consisted of 116 sixth grade students enrolled in two different schools. The subjects were of intermediate ability. The students were randomly assigned to the five treatment groups.

Treatments EA, E1, E2, and E3 were administered during 11 class periods, one period per day. Treatment E0 was started on the fourth day and extended through the eleventh day. The performance and learning set tests were administered on the twentieth and thirtieth days, respectively.

Due to absences, the analysis of the data were completed on 90 students, 18 students per treatment. No significant differences were found to exist among students' previous mathematics grades per treatment.

An analysis of the data indicated (a) that the positive transfer indexes ranged from .95 through 1.00, (b) that the performance test means per treatment were not significantly different, (c) that the learning set test means per contextual level for treatments E1, E2, and E3 were not significantly different, and (d) that the performance (final task) test and learning set test means for treatments E0 and EA were not significantly different.

Gagné and staff noted that attainment of a level of knowledge was dependent upon prior relevant subordinate knowledge. The variety of examples and the time lapse required for students to complete the examples did not have an effect on productive learning. Thus, the authors concluded that "...one can affect the efficiency of the learning process quite readily by manipulating the content and sequence of material, but not at all readily by manipulating the repetitiveness and temporal spacing of this content..." (Gagné and staff, 1963, p. 49).

Gagné and staff compared the results of this study with previous subordinate hierarchical research. They noted that knowledge hierarchies, when compared with other learning program variables, were the critical variable which affected the learner's ability to accomplish the final task. They also indicated that practice was not a significant variable.

Gagné and Bassler (1963)

This study identified that knowledge at the lower subordinate levels was not retained over a period of time, whereas, the capability to do the final task was retained.

The purpose of this study was to determine the effect that the subordinate hierarchy (topic sequencing), variety of examples, and time lapse between the completion of subordinate levels had on the retention of knowledge. This research was a follow-up study of Gagné and staff's study.

Retention after nine weeks was measured by a performance (final task) test and a learning set (subordinate hierarchy) test. These tests were developed by altering, in appearance and context, test items used in Gagné and staff's study.

The revised tests were administered to the subjects used in the previous study. Absences reduced the total number of students to 80, 16 students per treatment group.

An analysis of the data identified that the nine-week performance retention ratios per treatment were larger than the nine-week learning set retention ratios. The amount of retention was determined by computing a retention ratio between (a) the means of the immediate learning performance test and the means of the nine-week performance test per treatment (E1 = .75, E2 = 1.12, E3 = 1.20, EA = 1.08, and E0 = 1.28) and (b) the means of the immediate learning set test and the means of the nine-week learning set test per treatment group (E1 = .60, E2 = .88, E3 = .80, EA = .79, and E0 = .70). Gagné and Bassler noted that the tests administered immediately after the treatment may have provided an additional practice session which may have affected performances.

A significant difference was found to exist between the means of the nine-week performance test for treatments E1 and E0. E1 was also found to be significantly different from the combined means of the other treatments. No significant differences were found to exist among the learning set treatment means.

A significant difference was found to exist between the immediate and nine-week subordinate retention discontinuity rates. Discontinuity was defined as a change in the pass-fail pattern between adjacent learning sets. The retention of the subordinate learning sets was determined by (a) counting the number of learning set discontinuities per student performance on the immediate and nine-week learning set tests, (b) computing the immediate and nine-week discontinuity means per treatment, and (c) determining significant differences between immediate and nine-week discontinuity treatment means. A discontinuity score of 0 or 1 was considered ideal because the learner either passed all learning sets or passed all learning sets up to a point and then failed the remainder. The discontinuity means per treatment on the immediate learning set test ranged from 1.1 through 1.4, whereas, the range for the nine-week discontinuity means was 4.8 through 5.0.

Gagné and Bassler concluded (a) that the final subordinate task was not readily forgotten, whereas, the subordinate learning sets used to develop student capabilities to perform the final task were readily forgotten, and (b) that the subordinate hierarchical learning set pattern for forgetting was irregular.

The authors indicated that the use of topic sequencing of content was important for efficient learning. Also, the review of subordinate learning sets may be necessary when interrelating previously acquired final tasks with newly identified final tasks. They recommended that further research be conducted to determine if knowledge obtained from a subordinate hierarchy which has been used in a variety of situations and was related to the development of other final tasks would result in the retention of knowledge at the lower subordinate levels.

Gagné and Bassler also recommended that another study be conducted to determine why the minimal variety program (E1) had a reverse effect on retention of the final task. The authors speculated that the lack of discrimination resulting from the minimum variety of examples caused confusion.

Gibson (1969)

The results of this study confirmed (a) that variety and number of examples did not have an effect on learning set achievement or retention of the final and transfer tasks and (b) that IQ had a significant effect on learning set achievement and retention.

The need for Gibson's dissertation was based upon dichotomized research results concerning the effect practice and variety of examples had on principle learning. A principle was defined as the combining of two or more concrete concepts. The hypotheses tested were (a) that a large number of practice sessions following initial learning would increase the retention of a principle, (b) that a broad variety of practice examples would facilitate transfer to contextually related tasks, and (c) that a broad variety of practice examples would facilitate retention.

A subordinate hierarchy was developed. The final task was reading and recording decimals from a number line. The hierarchy consisted of three lower subordinate levels. For each level, the number of practice examples and the variety of the examples were varied. Ten or 25 practice examples were used per subordinate level. Broad variety examples consisted of varying the form, wording, or context of the practice items.

Major design changes in this study as compared with previous studies were holding learning level achievement constant and having the example practice session follow the initial learning phase. The latter was identified as overlearning. The use of learning programs in previous studies did not insure that all students achieved the same learning level. Also, the examples were included in the learning programs.

The procedure for conducting the study consisted of administering a pre-test, the lessons, the subskill tests, the practice booklets, the post-transfer and post-learning set tests, and the retention transfer and retention learning set tests.

The subjects consisted of 90 third and fourth grade students enrolled in an elementary school. The subjects were assigned to three IQ levels per grade level.

The pre-test consisted of ten items. The test was given to determine the subjects' familiarity with decimals.

The A.A.A.S. Science--A Process Approach, Third Experimental Edition, Part 5 was used to structure the objectives and plan the subordinate topic lessons. The lessons took seven class periods, one class period per day.

The subskill tests were used to insure that the students had achieved each subordinate level before they received their practice booklets. Students who did not pass the hierarchical subskill test received individual instructions and took equivalent subskill tests until they passed.

After the initial learning phase, the subjects were randomly assigned to one of the four types of practice booklets or to the control group. The four types of practice booklets were: broad variety, many examples (BM); broad variety, few examples (FM); narrow variety, many examples (NM); and narrow variety, few examples (NF). Word games were used during the practice session for the control group and for sutdents who completed the subskill tests and practice booklets before the rest of the students.

Tests designed to measure student learning consisted of an immediate post-learning set test, a retention learning set test, an immediate post-transfer test, and a retention transfer test. The transfer test was constructed to measure student capabilities to do the final task as well as apply a principle to contextually-related problem-solving situations. The learning set test consisted of five contextual level items per subordinate level.

An analysis of the data indicated (a) that the students achieved the initial learning criterion level expected, (b) that there was no significant difference between the subskill test means per treatment, (c) that the number and variety of examples did not have a significant effect on the post and retention learning set tests or the post and retention transfer tests, and (d) that IQ had a significant effect on the results of the post and retention transfer tests and the post and retention learning set tests. A 2 x 2 x 2 x 3 factoral design was used to determine the effect broad and narrow variety; many and few examples, third or fourth grade level; and high, medium, or low IQ level had on student performances.

Gibson concluded that overlearning, which had been identified as a significant variable in past verbal learning studies, was not a significant variable in principle learning. Thus, verbal learning and principle learning may not be governed by the same rules.

Wiegand (1969)

The results of this study indicated (a) that the completion of the final task and transfer task was dependent upon the transfer of intellectual skills and (b) that the retest procedure had an effect on student capabilities to do the final task.

Wiegand's study was conducted to compare Piaget's innate cognitive developmental paradigm with Gagné's cumulative learning paradigm. A basic premise of Gagné's paradigm was that external stimulus had an effect on the development of the learner's cognitive capabilities.

Specific hypotheses tested were (a) that there would be differences in patterns of capabilities to complete the final task, (b) that the completion of previously non-achieved subordinate hierarchical operations would enable students to complete the final task, (c) that the subordinate hierarchy used to plan instructional and/or testing procedures would enable students to be able to complete the final and transfer tasks and (d) that students who completed the final task would be able to complete the transfer task.

In the introduction of the study, Wiegand briefly reviewed Gagné's cumulative learning paradigm.

> The intellectual development of the child proceeds, not because of the increasing numbers of associations formed between stimuli and responses, but because of the learning of ordered sets of capabilities that build upon each other in progressive fashion by means of the processes of differentiation, recall, and transfer of learning. It is proposed that the entities that are learned in a learning sequence are relatively specific intellectual skills. (Wiegand, 1969, pp. 9 - 10).

> They are specific enough so that one must specify them by naming the class of properties of external objects or events to which they will apply. At the same time, they possess great potential for generalization, through combination with other learned entities by means of a little understood, but nevertheless dependable mechanism of learning transfer. (Gagné, 1968a, p. 189, quoted by Wiegand, 1969, p. 10).

A task developed by Piaget and Inhelder was used as the transfer task. The task involved a car on an inclined plane. The car was counter-balanced by a weight hanging from a pulley. (See Figure 8.) The learner was required to predict the equilibrium position of the car as the function of (a) the weight in the car, (b) the counterweight, and (c) the angle of the track.

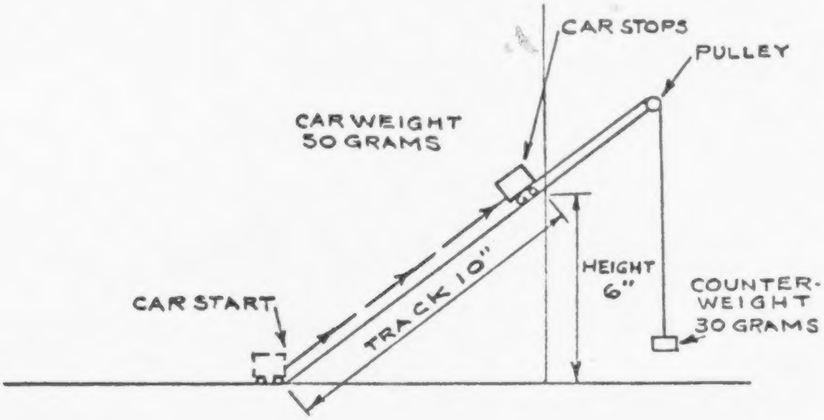

CAR STOPS
PULLEY
CAR WEIGHT
50 GRAMS
HEIGHT
6"
TRACK 10"
CAR START
COUNTER-
WEIGHT
30 GRAMS

Figure 8. Problem Identified by Piaget and Inhelder Used by Wiegand as the Transfer Task (Wiegand, 1969, p. 15)

The final subordinate task involved the use of the same equipment. (See Figure 9.) The task required the students to predict the movement of a block of wood as the result of the loaded car striking the block.

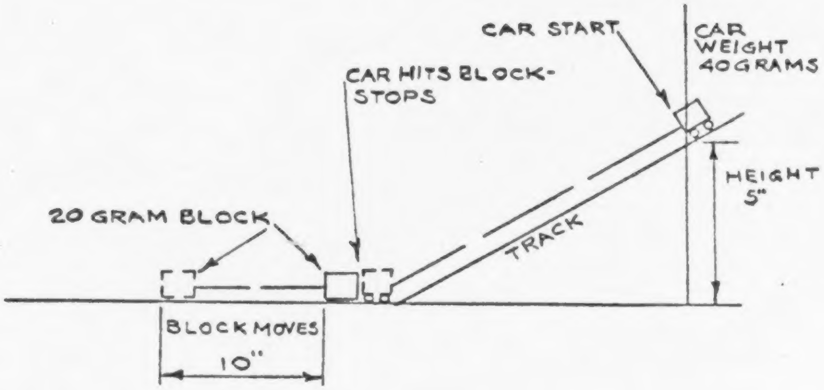

CAR START
CAR
WEIGHT
40 GRAMS
CAR HITS BLOCK-
STOPS
HEIGHT
5"
20 GRAM BLOCK
TRACK
BLOCK MOVES
10"

Figure 9. Final Task (Wiegand, 1969, p. 18)

A subordinate hierarchy was developed. (See Figure 10.) The hierarchy was used to (a) determine capabilities related to the final task, (b) design a learning sequence starting at each student's level of incapability, (c) maximize positive transfer, and (d) construct a subordinate learning set test. The test consisted of two or three items per hierarchical level. The students were required to pass both items, or two out of three items, per subordinate level to indicate their mastery of a learning set.

The subject matter for the learning sequence (demonstration) and learning set test was different from the final task test. The intellectual operations required were the same for all three.

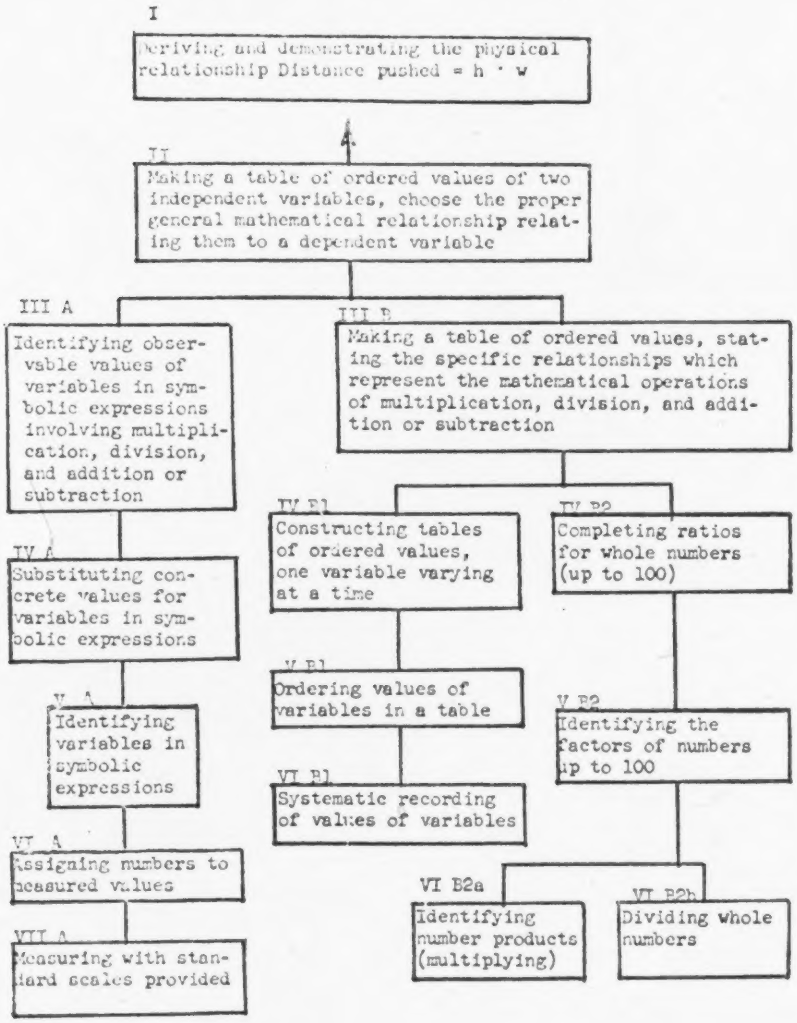

I
Deriving and demonstrating the physical relationship Distance pushed = h · w
II
Making a table of ordered values of two independent variables, choose the proper general mathematical relationship relating them to a dependent variable
III A
Identifying observable values of variables in symbolic expressions involving multiplication, division, and addition or subtraction
III B
Making a table of ordered values, stating the specific relationships which represent the mathematical operations of multiplication, division, and addition or subtraction
IV A
Substituting concrete values for variables in symbolic expressions
IV B1
Constructing tables of ordered values, one variable varying at a time
IV B2
Completing ratios for whole numbers (up to 100)
V A
Identifying variables in symbolic expressions
V B1
Ordering values of variables in a table
V B2
Identifying the factors of numbers up to 100
VI A
Assigning numbers to measured values
VI B1
Systematic recording of values of variables
VI B2a
Identifying number products (multiplying)
VI B2b
Dividing whole numbers
VII A
Measuring with standard scales provided

Figure 10. Subordinate Hierarchy of Intellectual Operations for Deriving and Demonstrating the Physical Relationship -- Distance Pushed = H x W (Wiegand, 1969, p. 21)

The subjects were 30 sixth graders with IQ's ranging from 90 through 125. The subjects were unable to complete the transfer and final tasks.

The procedure for conducting the sutdy involved administering the pre-test, administering the treatment, and administering the post-test. The pre-test involved randomly selecting changes in two out of three final task and transfer task variables. Nine different possible combinations of variables were demonstrated for each task. The students were required to predict the movement of the car or block, depending upon the task. All testing was done individually.

Next, the subjects were randomly assigned to one of the three treatment groups. The variables manipulated were: (a) how the learning set test was administered and (b) how many times the learning set test was administered. (See Table 3.)

When the learning set test was administered the first time, the test items were organized from the highest subordinate level to the lowest. The order of the items was reversed when the test was administered the second time.

Table 3. Sequence of Experimental Events Used by Wiegand to Conduct Her Study (Wiegand, 1969, p. 36)

Treatment	Pre-test	Learning-Testing Sequence	Post-test
DTR	Final task Transfer task	Demonstration test Retest	Final task Transfer task
TR	Final task Transfer task	Test Retest	Final task Transfer task
T	Final task Transfer task	Test	Final task Transfer task

The DTR treatment involved (a) presenting a problem related to a specific learning set level, (b) demonstrating the solution of the problem step by step, and (c) administering the learning set test items related to the subordinate level demonstrated. The student was required to pass two subordinate level test items before he started the adjacent lower subordinate task. After the demonstration test was completed, the learning set retest was administered.

The TR treatment was similar to the DTR treatment, except that the demonstration was not included. The T (control) group was required to complete the initial learning set test only.

After the testing and/or demonstration sequence had been completed, each student was administered the final and transfer task tests. If the student was able to complete the final task successfully, he was required to identify a missing value in the rule formula.

This was done to determine how well he understood the rule he had used to solve the final task.

An analysis of the data identified (a) that the subjects were unable to complete the initial final and transfer tasks, (b) that capabilities to do the initial final task varied, (c) that 6, out of 286 possible pass-fail combinations, passed a higher subordinate task without passing the lower adjacent task, (d) that there was a significant change in the number of students who completed the post-final task test as compared with the number who passed the pre-final task test, (e) that 22 subjects successfully completed the post-final task test, (f) that the same 22 subjects passed all the adjacent subordinate level tasks, (g) that performance of the DTR and TR treatments on the learning set retest was significantly different from their performance on the pre-learning set test, (g) that the retest (TR treatment) procedure had a significant effect on student capabilities to complete the subordinate hierarchical tasks, (i) that all subjects who successfully completed the post-final task were able to complete the post-transfer task, and (j) that ordering data and deriving correct relationships were significant variables which affected the DTR and TR students' capabilities to complete the final task.

In summary, Wiegand stated that the subordinate hierarchy enabled the students to complete final and transfer tasks they were previously unable to complete. Also, the retest was a significant variable which enabled students to complete the subordinate hierarchical tasks.

The author noted that the performance required of the subjects on the "...final and transfer tasks was not a matter of training on the final task" (Wiegand, 1969, p. 53). The students completed the final task as the result of having acquired subordinate intellectual operations that were related to the final task. It was assumed that these operations enabled the students to develop cognitive capabilities to process information related to the final and transfer tasks (Wiegand, 1969, p. 53).

Wiegand concluded that intellectual development was "...brought about by the cumulative effects of learning concretely-referenced intellectual skills, rather than by the adaptation of structures of intellectual growth" (Wiegand, 1969, pp. 61-62). Further research was recommended to determine why the retest procedure and not the demonstration procedure had an effect on students developing intellectual operations.

Coleman (1969)

This study identified that the use of the process approach in social science depended upon specifying and ordering intellectual operations. The objectives of the study were to identify evidence (a) that the accomplishment of higher subordinate levels was dependent upon the accomplishment of lower levels, (b) that the subordinate hierarchy enabled students to perform the final intellectual process of comparing, and (c) that the rules for comparing exports from countries were transferable to other contextually-related problem-solving situations.

The procedure for conducting the study consisted of (a) developing a subordinate hierarchy, (b) constructing pre- and post-learning set tests, (c) preparing final and near- and far-transfer tasks, (d) planning an instructional program, (e) collecting data, and (f) analyzing the data. The final task selected was: "Given a detailed list of exported items and their monetary value for two countries, formulate a summary comparison of the exports of the two countries in terms of a limited number of categories which are exhaustive and exclusive" (Coleman, 1969, as quoted in Gagné, 1970, pp. 36-37). The subordinate hierarchy consisted of three major classes of tasks: quantitative comparisons, generating conceptual categories, and table interpretations.

The tests used to measure student performances were similar to those developed by Wiegand. The final task test booklet and learning set tests included example problems and problems to be solved. The learning set test consisted of two problems to be solved for each of the 21 subordinate hierarchical levels. The subject matter for the learning set tests was not the same as the final task. The same test items were used for both the pre- and post-learning set tests. For the pre-learning set test the problems were arranged from highest to lowest subordinate level.

The near-transfer comparing task was in the area of ecology. The far-transfer task was concerned with medical research.

The subjects consisted of 20 girls randomly selected from students enrolled in an elementary school The subjects were above the 65th percentile on both the verbal and nonverbal sections of the Lorge-Thorndike Intelligence Test. The subjects IQ's ranged from 111 through 138.

After the subjects were administered the final task and the pre-learning set test, they were randomly assigned to one of two treatment groups. Subjects in the experimental group received individualized instruction. The instruction was designed to enable the learner to identify, learn, recall, and apply the subordinate tasks missed on the pre-learning set test. The control group received no instruction.

Both treatment groups were required to complete the post-learning set test and the final task. Next, both groups were administered the near- and far-transfer tasks.

An analysis of the data indicated (a) that the a priori positive transfer pass-fail patterns on both learning set tests did not occur as often as expected; (b) that the subjects did not lack the quantitative capabilities as identified in the quantitative branch of the subordinate hierarchy; (c) that the students who received instruction improved on the post-learning set test; (d) that all the subjects in the experimental group passed the final task, whereas, none of the control group passed the task; and (e) that the experimental group did significantly better on the near- and far-transfer tasks than did the control group.

Coleman concluded that the use of the process approach in social science was dependent upon identifying the ordering intellectual operations. Also, students who were able to complete the final task were able to complete the near- and far-transfer tasks.

Gagné and Okey (1970)

This study illustrated the use of a subordinate hierarchy to restructure a learning program in the area of chemistry.

The authors predicted that Gagné's subordinate hierarchy could be used effectively to locate topic sequence irregularities in programmed instructional materials. This prediction was based upon the assumption that student intellectual skills that have not been organized in an hierarchical order would result in them not being able to complete the final task. Thus, the objective of this study was to test the above prediction.

The chemistry learning program selected for conducting the study was entitled, "Equilibrium Calculations: Solubility Product." A subordinate hierarchy was developed and used to (a) revise the original instructional program, (b) develop pre- and post-criterion (final task) tests, and (c) develop pre- and post-learning set tests. The pre- and post-criterion tests consisted of six pairs of test items. The range of the equivalence index for the items was .84 through 1.00. The mean was .90 . The equivalence item indexes for the pre- and post-learning set tests ranged from .81 through 1.00, with a mean of .95 .

The equivalence index was determined by administering the paired test items to students. The pairs were considered equivalent if a student passed or failed both paired items. The index was computed by adding the number of students who passed or missed the equivalent paired items by the number of students tested.

The subjects consisted of 106 tenth through twelfth grade students enrolled in five chemistry classes. Alternating students from an alphabetized listing were assigned to one of two treatment groups.

The control group was administered the pre-criterion task test, the pre-learning set test, the original program, the post-criterion test, and the post-learning set test. The performance of the control group on the post-criterion test identified that the program was moderately effective.

The analysis of the data from the post-learning set test was used to revise the learning program. Specific changes made were concerned with exponential notation, translating verbal problems into mathematical statements, and determining the concentration of ions in solution.

The testing procedure used for the control group was used for the experimental group, except for the program. The revised program took the students a period longer to complete.

A one-way analysis of covariance was used to analyze the data. Standardized mathematics achievement scores, IQ, pre-criterion test scores, and pre-learning set test scores were used as covariates. The experimental group did significantly better on the post-criterion test than did the control group. Also, significant improvement was found between the experimental and control groups' performances on the subordinate hierarchical subtasks. Improvement occurred on 12 out of the 15 subordinate subtasks.

Gagné and Okey concluded that the use of the subordinate hierarchy to revise an instructional program had an effect on learning. The subordinate hierarchy was effective in identifying instructional irregularities in the original learning program.

Superordinate Organization of Intellectual Skills

The results of Gagné and Wiegand's study in 1968 resulted in further research being conducted. The research conducted was concerned with the effects which superordinate contextual materials had on rule learning and retention.

The conclusions derived from the superordinate studies were (a) that the retention of isolated facts was significantly greater than contextually-related facts (Gagné, 1969), (b) that the retention of superordinated contextually-related facts was significantly greater than coordinated or unrelated learning materials (Gagné, 1969), (c) that familiarity with learning materials had an effect on meaningful learning (Wiegand, 1968; Gagné, 1969; Gagné & Wiegand, 1970), (d) that interference exerts its major effect on the storage-retrieval phase of learning (Gagné, 1969), and (e) that organizers have a significant effect on retention when they are used for cueing recall (Gagné & Wiegand, 1970).

Gagné and Wiegand (1968)

The results of this study identified that isolated rules were not readily retained after three days.

Gagné and Wiegand conducted this study to determine the effect the number of concrete rules, sometimes called facts, had on learning and retention. The combining of two concepts was defined as a simple rule. A rule could be either concrete, abstract, or a combination of both depending upon the nature of the concepts that formed the rule. Specific questions asked were: How many concrete rules can be learned during one time period? What cueing technique is used to retain rules?

The design of the study involved the learning of CVC thing concepts, action concepts, and concrete rules. CVC names were defined as nonsense words consisting of a consonant, vowel, and consonant. Thing concepts consisted of drawn shapes labeled by CVC words. Action concepts involved CVC shapes that required the students to perform a specific action related to the shape. The learning of concrete rules required the learner to combine the CVC thing concept with an action concept.

The materials used to conduct the research consisted of CVC thing and action concept study skill sheets, concept learning tests, rule learning booklets, and rule learning tests. The CVC concept test required the students to draw the concept shape for the CVC name identified. The action concept test required the students to draw a circle around the action that was correctly associated with a specific shape.

The rule learning booklets (a) identified the thing concept (This is a NOP.), (b) stated the rule (A NOP has a circle drawn around it.), (c) illustrated the rule, and (d) instructed the student to draw the rule. The booklets used to test the students' immediate learning or retention of the rules required the students to draw the rule related to a specific CVC name. Half of the booklets included the shape of the thing concept illustrated below the CVC name. This was done to determine the effect words or shapes had on cueing.

The subjects consisted of 96 fourth grade children enrolled in a middle-class suburban elementary school. The subjects were divided into six IQ levels and randomly assigned to one of the 16 treatment groups. Each treatment group consisted of 16 students. (See Table 4.) The treatment variables were (a) immediate testing versus delayed testing, (b) use of verbal versus verbal and pictorial cues, and (c) exposure to three, five, seven, or nine rules.

Table 4. Number of Subjects Assigned to Treatment Cells (Gagné & Wiegand, 1968, p. 357)

Retention Condition	Cueing Condition	Number of Rules 3	5	7	9
Immediate	Verbal	6	6	6	6
	Verbal and Pictorial	6	6	6	6
Delayed	Verbal	6	6	6	6
	Verbal and Pictorial	6	6	6	6

The procedure for conducting the study involved students learning the names of the thing concepts during four consecutive school days, one period per day. The fifth day was devoted to the learning of action concepts. The rule learning booklets were administered on the sixth day, with one-half of the subjects receiving the rule learning test booklets on the same day. The other half of the subjects received the test three days later, on the ninth day. Thing and action concept tests were administered during the first five days. Filler material was used to control time during the learning phase of the experiment.

An analysis of variance on the data collected identified (a) that IQ and verbal versus verbal and pictorial cueing were nonsignificant variables, (b) that performances on the rule learning test immediately after learning were significantly different from the performances on the delayed rule learning test, and (c) that there was no significant difference among the number of rules learned as measured by the immediate and delayed rule learning test. One-hundred percent immediate recall occurred for the three and five rule learning conditions. The percentage of recall for the seven and nine rule conditions were .80 and .60, respectively. The percentage of recall for the three, five, seven, and nine rule learning conditions was about .20 after three days.

The authors concluded that the significant drop in retention was probably due to interference. They suggested further research needed to be done to determine the amount of retention of isolated versus context-imbedded ideas.

Gagné (1969)

The results of this study indicated (a) that the retention of isolated facts was significantly greater than the retention of contextually-related facts, (b) that the retention of superordinated contextual facts was significantly greater than the coordinated or unrelated contextual material, (c) that the retention of coordinated contextual facts was significantly greater than the unrelated contextual facts, and (d) that the use of the topic sentence for cueing recall was significant, regardless of whether superordinate or coordinated material was used during the initial learning phase.

Gagné conducted this study to identify what effect learning isolated and meaningful contextual materials had on retention. Specific topics of interest were the influence "organizers" and interference had on retention.

The rationale for this study was based upon contrasting research findings concerning contextual and isolated learning materials. Gagné identified that Ausubel's and Rothkopf's research has illustrated that contextually-related learning materials facilitate retention. The findings of Gagné and Wiegand's study identified that interference reduced the retention of isolated learning materials. Keppel identified that rote-learned materials embedded in similar contextual materials had an adverse effect on retention.

The design of the study involved students learning facts about monkeys; the facts being organized in a superordinated, coordinated, unrelated and isolated context. The subjects consisted of 56 fourth and 56 fifth grade students enrolled in a middle-class elementary school. The subjects were divided into seven IQ levels representing a range from 83 through 139. The median was 119. The five facts which the students were expected to learn and retain were:

(a) young howlers wrestle and chase each other in play;

(b) mother howler monkeys carry their babies with them wherever they go;

(c) howlers roar and throw objects at animals they are afraid of;

(d) a howler uses his tail as another hand;

(e) howler monkeys prefer to live in forests of tall trees (Gagné, 1969, p. 409).

The superordinated contest consisted of five paragraphs of learning materials. Each paragraph consisted of five sentences. Four sentences of each paragraph were related to the fifth, the topic sentence. The topic sentences were concerned with "...(a) howler play, (b) mother-child relationships, (c) actions toward enemies, (d) the howler's tail, and (e) forest living" (Gagné, 1969, p. 409).

The coordinated context consisted of the same five paragraphs except the topic sentence was changed to a fact sentence. The unrelated context involved four out of the five sentences describing the appearance and habits of other animals as well as the terrain in which the animals lived. The presentation of the five facts, by themselves, was used to operationally define the isolated context.

The students' retention was measured by a recall and recognition fact test (recall test) and a context recognition test (context test). The recall test required students to check the paraphrased fact statements they recognized and to fill in the blank space provided for each statement they recognized.

The context test consisted of true and false items. The test was altered to meet each contextual treatment condition.

The procedure for conducting the study consisted of randomly assigning the students grouped by IQ levels to eight treatment groups, four treatment groups per grade level. All students received the same introduction to the material being studied.

The treatments were administered by projecting each statement on a screen. Next, each fact was read by the experimenter. The students were required to fill in the blank space found in the statements in their instructional booklets.

The time between the presentations of the fact statements to be remembered was held constant. For the isolated context, the five fact statements were presented every 15 seconds. The fact statements to be remembered by the rest of the treatments were administered every 60 seconds.

A four-factor analysis of variance procedure was used to analyze student performances on the recall test. The factors were grade level, IQ, treatment, and time. The analysis identified grade level and treatment as significant variables. The retention of isolated facts was found to be significantly greater than the retention of the fact when placed in contextually-related learning materials. Also, the retention of the superordinate context was significantly greater than the coordinated or unrelated facts. The coordinated context was significantly greater than the unrelated context.

An analysis of the student performances on the context test identified that grade level was the only significant variable. The context test treatment means were in the same hierarchical order as the recall treatment test means. A significant interaction between massed spaced presentation and grade was identified. The space condition yielded higher context test scores for fifth graders, whereas, the massed condition yielded higher scores for fourth graders. The latter may have resulted from fifth graders being more intellectually mature and/or having acquired more efficient means for remembering.

Gagné concluded (a) that interference has a significant effect on the retention for contextually-related materials; (b) that interference probably exerts its effect during the storage-retrieval phase of remembering; (c) that superordinate context has a significant effect on retention, hence reducing the effect of interference; and (d) that the type of isolation in Gagné and Wiegand's 1968 study was different than the isolated context treatment used in this study. Gagné identified that the research findings of this study supported Ausubel's research concerning "anchoring rules" and "organizers."

Gagné and Wiegand (1970)

This study identified that topic sentences ("organizers") presented during the recall test improved retention.

Gagné and Wiegand conducted this study to further investigate the effects superordinate contextual materials had on learning and retrieval. This research was conducted as a follow-up of Gagné's 1969 study.

The procedure for conducting this study was similar to the 1969 study. The materials used consisted of 25 fact sentences about monkeys, a recognition and recall (recall) test, and a context recognition (context) test. The recall test included five groups of four fact statements each. Three out of the four fact statements were not included in the learning materials.

The subjects consisted of fourth grade students enrolled in a predominately middle-class elementary school. The subjects were assigned to one of eleven IQ levels. The IQ's ranged from 85 through 145, with a median of 113.

The procedure for collecting the data consisted of randomly assigning the subjects to one of four treatment groups. The four treatments involved (a) the use of the topic sentence during learning only, (b) the use of the topic sentence during learning and recall, (c) the use of no topic sentence during learning or recall, and (d) the use of the topic sentence during recall only.

For all treatment groups, the 25 statements were projected individually on a screen and read by the experimenter. Next, each statement was read from the treatment booklet. The students were required to fill in the blank space found in each statement. The recall and context tests were administered 48 hours after the instructional sequence had been completed.

The analysis of the data indicated (a) that the use of the topic sentence for cueing recall had a significant effect on retention, regardless of whether superordinate or coordinated material was used during the initial learning phase; (b) that the use of the topic sentence during learning did not have a significant effect on recall; (c) that IQ was an insignificant variable; and (d) that the pattern of results on the context test was the same as the pattern of results on the recall test.

Gagné and Wiegand concluded that the findings of this study were consistant with the previous study. The results verified that "organizers" have an effect on the retention phase of learning, as compared with the initial learning phase.

The authors indicated that the significant differences found between fourth and fifth graders in the 1969 study probably resulted from differences in language maturity.

Use of Research Findings to Conduct Study

The subordinate hierarchical and superordinate research findings were used to plan the instructional procedures for the NV + V_c and V treatments and to develop tests to measure the amount of abstract learning.

Instructional Procedures

The subordinate hierarchy was used to identify and interrelate intellectual operations necessary for students to acquire an abstract understanding of a technical principle. The hierarchy of intellectual operations was used to organize, structure, and plan the instructional procedures for the NV + V_C and V treatments. Care was taken not to use an organizer during the learning phase. An organizer was used to cue recall at the beginning of the testing phase. Positive transfer indexes were computed to evaluate the effectiveness of the subordinate hierarchy (Gagné, 1968b).

Measurement of Abstract Learning

Final task, transfer task and learning achievement (learning set) tests were developed to measure the amount of learning. The final and transfer task tests were used to measure the student's ability to apply his abstract (verbal) understanding of a technical principle to contextually-related problem-solving situations.

The learning achievement test was used to determine the amount of previous verbal learning students had acquired about a technical principle and the subordinate hierarchical level each treatment achieved. More than one test item was used per subordinate hierarchical level.

CHAPTER III

METHODS AND PROCEDURES

This chapter reviews the methods and procedures used to conduct the study. The major phases involved (a) selecting a technical principle, (b) developing a subordinate hierarchy, (c) producing video-taped lessons, (d) determining the reliability of the test instruments, (e) collecting data, and (f) establishing procedures for analyzing data.

Selection of a Technical Principle

The identification of a technical principle consisted of specifying criteria and determining a procedure for selecting a principle. The criteria circumscribed the nature of concept learning.

Determination of Criteria

The criteria selected were based upon the purpose of the study and Gagné's learning paradigm. A technical principle utilized to conduct the study had to (a) meet the criteria of rule (principle) learning as defined by Gagné, (b) be technically based, (c) have general application, (d) consist of concrete concepts that could be operationally defined, (e) be one that could be presented to students in one class period, (f) be one to which most seventh and eighth grade students would not have been exposed, (g) lend itself to the "learning by doing" approach (NV + V_s treatment), and (h) be at the students' cognitive developmental level. (See Appendix A, pp. 196 - 198.)

The criterion that the principle consist of concrete concepts specified that it be environmentally based. Concrete concept learning involves the use of environmental stimuli to operationally define the meaning of a concrete concept label.

The criterion that the principle be presented in one class period limited the level of generalization. For example, forming has been defined by Lindbeck and Lathrop (1969, p. 107) as "...the process of shaping a material without adding to or removing any of the material." The students could not have been expected to develop a level of understanding of this principle in one class period which would enable them to realize that forming includes the processes of bending, extruding, forging, pressing, drawing, casting, and rolling.

The criterion that the principle be one to which seventh and eighth graders had not been exposed limited the effect of cumulative learning. This criterion was imposed to insure that learning did occur during the treatment period.

Selection of a Technical Principle

The procedure employed for selecting a technical principle involved making a list of principles and having the list evaluated by a committee. The committee consisted of five West Virginia University faculty members and 15 junior high school industrial arts teachers. The latter were from the county in which the final study was conducted.

The researcher identified a list of 46 principles. Using the criteria identified, the researcher reduced the list to 16. A large number of the principles were related to plastics. This area was not included in the county's junior high school industrial arts programs.

The survey forms used by the committee members to select a principle consisted of a list of criteria and the 16 principles. (See Appendix B, pp. 199- 202 .) The university faculty members were requested to evaluate the principles by using all of the criteria previously identified. The junior high teachers were requested to base their selection upon criteria (e), (f), and (h), found on page 83. The teachers were requested not to include the 16 principles in their courses during the school year.

Thermoforming was selected as the technical principle for conducting the study. All 20 committee members ranked thermoforming first, second, or third.

Development of the Subordinate Hierarchy

The subordinate hierarchy was used as a means for structuring the NV + V_c and V instructional guidelines. The procedure employed to develop the hierarchy involved (a) defining thermoforming, (b) identifying subordinate intellectual operations, and (c) determining the effectiveness of the subordinate hierarchy. Positive transfer indexes were computed to determine the effectiveness of the hierarchy.

Definition of Thermoforming

Thermoforming was defined as the process of heating a thermoplastic plastic sheet to its shaping temperature, stretching the hot plastic against a mold by the use of air and/or vacuum to exert a force, and using air or vacuum to hold the material against the mold until the plastic has set (Society of, 1960; McConnell, 1968, 1970).

The above definition was derived by updating the definition of thermoforming found in the Plastic Engineering Handbook (1960). In annual editions of the Modern Plastics Encyclopedia, experts have reviewed recent developments in plastics. In the 1967 and 1970 editions, McConnell developed an extensive classification system for categorizing thermoforming procedures. This system included recent developments. Attributes that were common across all the classifications were used to redefine the Society of the Plastics Industry's definition.

Determination of Subordinate Intellectual Operations

The identification of a hierarchical order of intellectual operations required specifying the final subordinate task and asking a question of the task. Guidelines were established to help two West Virginia University faculty members evaluate the researcher's hierarchy. (See Appendix C, pp. 203 -204.) The initial hierarchy developed consisted of 19 subordinate tasks. (See Appendix D, pp. 205 - 208.)

The final subordinate task was: The student will be able to identify and order the major attributes of thermoforming that would result in the production of a product. The question asked of the above task and each identified lower subordinate task was: "What would the individual already have to know how to do in order to learn this new capability simply by being given verbal instruction?" (Gagné, 1968b, p. 3). A list of intellectual operations and major attributes of thermoforming were employed by the researcher to state each identified subordinate task.

The researcher's hierarchy of intellectual operations was evaluated by two faculty members. Each member was asked to evaluate the hierarchy based upon his expertise in industrial arts education or plastics. The interaction among the faculty members and the researcher resulted in the simplification of the subordinate hierarchy. The criterion used to simplify the hierarchy was the intellectual maturity of seventh and eighth grade students. The means used to make revisions involved identifying student objectives per superordinate level. The objectives were:

Level V : The students will use verbal terms which they are already familiar with to label environmental stimuli related to thermoforming.

Level IV : The students will acquire an understanding of the meaning of the verbal terms used to describe environmental stimuli related to thermoforming.

Level III: The students will identify interrelationships between environmental stimuli and the effect the interrelationships have upon each other as they relate to thermoforming.

Level II : The students will identify interrelationships between verbal codes previously acquired to code the meaning of the observed interrelationships.

Level I : The students will identify interrelationships between environmental stimuli concerned with thermo (Branch A) and forming (Branch B) and will use verbal codes previously acquired to code the meanings of these interrelationships.

Level I involves students interrelating concrete and/or relational concepts to depict the effect the presence or absence of heat has on producing or maintaining the shape of thermoplastic plastic sheets.

The faculty members and the researcher made two observations regarding the use of the subordinate hierarchy to develop students' abstract understanding of thermoforming. In previous research by Gagné and associates, instruction was administered by using subject matter that was different from the final subordinate task. It was predicted that the use of this approach would result in specific attributes of thermoforming not being operationally defined. For example, the effect which heat has on thermoplastic plastic sheets could not be demonstrated by using another material.

The second observation, based upon the first one, was that technical principles are very specific. Thermoforming is defined by how each attribute of thermoforming interacts with other attributes.

Measurement of Positive Transfer

The computation of positive transfer indexes used to measure the effectiveness of the subordinate hierarchy involved (a) identifying behavioral objectives for each subordinate task; (b) determining guidelines for developing the final task, transfer, and learning achievement (set) tests; (c) constructing the final task, transfer, and learning achievement tests; (d) planning the NV + V_c lesson; (e) administering and evaluating the NV + V_c lesson; (f) administering and evaluating the final task, transfer, and learning achievement tests; and (g) using student performances on the learning achievement test to determine the amount of positive transfer. The completion of (e), (f), and (g) required conducting three pilot studies at three different junior high schools.

The behavioral objectives were similar to the subordinate tasks identified in the initial subordinate hierarchy. (See Appendix D, pp. 205 - 208.) The guidelines used for constructing the tests were developed from the review of research described in Chapter II. (See Appendix E, pp. 209 - 211.)

The final task and transfer task were designed to determine the amount of abstract learning. The final task test was developed to measure the students' capability to identify and order the major attributes of thermoforming. The initial test consisted of six different descriptions of thermoforming. Each description involved the construction of a tote tray. The students were required to identify those procedures that would result in the tray being produced. For each incorrect procedure, the students were requested to specify the inaccuracy and make the necessary corrections. A student received a point for each description he identified correctly. He received an additional point for determining each incorrect attribute of thermoforming and for correcting each incorrect attribute. The total of possible points on the test was 12.

The researcher redefined the criteria used by Gagné and associates for structuring transfer tests. Gagné identified that the students who have acquired a rule should be able to use the rule to solve novel, contextually-related problems. Gagné varied the context by changing the subject matter of the final subordinate task. The problem encountered by the researcher was that when the context of a technical principle was varied by changing the subject matter, the abstract understanding of the technical principle being measured was no longer thermoforming.

The procedure used by the researcher to vary the context involved identifying similar but different processes in the area of plastics. These non-thermoforming processes were used as distractors for developing a transfer test which required students to identify thermoforming processes.

The test consisted of seven descriptions of thermoforming or non-thermoforming procedures. For each non-thermoforming procedure identified, the students were requested to explain why the process was not thermoforming. The total of possible points on the test was 15.

The purposes of the learning achievement test were to determine (a) the subordinate hierarchical level students had achieved and (b) the amount of verbal knowledge the students had acquired. The test was constructed by writing two or three multiple-choice test items per subordinate task. (See Appendix D, pp. 205 - 208.) The items were organized from the lowest subordinate level to the highest. Each test item was worth one point. The total of possible points on the test was 34.

The procedure used to plan, administer, and evaluate the $NV + V_c$ lesson involved (a) identifying the role of the verbal and nonverbal media per subordinate behavioral objective, (b) outlining the role of each medium on five-by-eight cards, (c) rehearsing the lesson twice, (d) presenting the lesson to students, (e) recording student reactions to the nonverbal medium used to give the lesson, (f) recording the verbal medium, and (g) interviewing the students. The students' reactions to the use of the nonverbal medium were recorded by the researcher after the lesson was given. A tape recorder was used to record the verbal medium.

The evaluation of the final task, transfer, and learning achievement tests involved (a) analyzing student performances on each of the three tests, (b) computing difficulty indexes and discrimination indexes for each learning achievement test item, (c) plotting discrimination curves for each learning achievement test item, and (d) interviewing students. For each pilot study a no-treatment and/or a $NV + V_s$ treatment was administered. Differences between student performances per treatment were used to evaluate the final and transfer task tests.

Item difficulty indexes (D.I.) were used to indicate whether an item was too easy or too hard. For each test item an indes was computed by dividing the number of students who passed the item by the number of students who took the test (D.I. = n passed item/n). Test items with indexes between .25 and .75 were considered acceptable.

Discrimination indexes (Disc. I.) were computed to determine whether test items were discriminating positive or negative. A positive index indicated that students who performed well on the test passed the item. The formula used to compute discrimination indexes was:

$$\text{Disc. I.} = \frac{\text{n passed item} > x_{50} - \text{n passed item} < x_{50}}{n/2}$$

The ability of an item to discriminate consistently was determined by plotting item discrimination curves. The curves were plotted by ranking the students' performances on the learning achievement test. Next, the scores were divided into subdivisions, preferably ten. Scores near the median were removed to make each subdivision equal. The subdivisions were plotted along the X axis, from the lowest grouping to the highest. The number of students per subdivision was plotted along the Y axis. For each subdivision the number of students who passed the item was plotted. An "S"-shaped ogive curve was considered ideal.

The effectiveness of the subordinate hierarchy was determined by computing positive transfer indexes between adjacent subordinate tasks. The performances of the NV + V_c and V treatment groups on the learning achievement test were used. Each test item was related to a specific subordinate task.

The formula used to compute the indexes was:

$$\text{P.T.I.} = (1 + 2) / (1 + 2 + 3)$$

1 = the number of higher level and adjacent lower-level learning sets passed between a specified subordinate task (++).

2 = the number of higher-level and adjacent lower-level learning sets failed between the specified subordinate tasks (– –).

3 = the number of higher level learning sets passed and adjacent lower-level sets failed between the specified subordinate task (+ –).

The procedure used to determine the ++, – –, and + – patterns involved (a) determining test items which meet the item difficulty and discrimination criteria previously described and (b) identifying a rule for assigning a + or – to NV + V_c and V student performances on test items related to each task. A + was assigned to each task when students passed (a) one test item related to a subordinate task, (b) two items related to a task, or (c) two out of three items related to a task.

The researcher did not expect the positive transfer indexes to be comparable with those computed by Gagné and associates. The criteria established for evaluating test items implied that very few students would pass all of the test items.

Pilot Study Number One

Pilot study number one consisted of 99 students enrolled in 6 seventh grade industrial arts classes. Three of the classes were administered the NV + V_c lesson. All six classes were given the final task, transfer, and learning achievement tests. The tests took three consecutive periods to administer, one period per day.

An evaluation of the NV + V_c lesson indicated that the lesson was too difficult. Also, a more effective means had to be developed for demonstrating (a) the effect heat had on thermoplastic versus thermosetting plastic, (b) the definition of a sheet, (c) the effect which different heat ranges had on thermoplastic plastic sheets, and (d) the use of air and vacuum to stretch a material. The general reaction of the students was that they enjoyed the lesson.

Student performances on the final task and transfer tests indicated that the tests were too difficult and/or the students had not achieved the higher subordinate levels. From observing students taking the tests and interviewing students, the researcher determined that reading ability and the lack of personal effort by students were variables that may have affected the test results.

The mean scores on the final task and transfer tests for the no-treatment and treatment groups were near chance (Final task: no-treatment = 3.13, NV + V_c = 4.09; Transfer test: no-treatment = 3.80, NV + V_c = 3.80). Chance scores for the final and transter task tests were 3.0 and 3.5, respectively.

The mean score for the NV + V_c treatment on the learning achievement test was 18.77. The range was from 8 through 26. The mean for the no-treatment group was 9.60, 1.10 better than chance.

Item discrimination curves, D.I., and Disc. I. signified 8 out of the 34 learning achievement test items did not meed criteria previously established. Most of these items were in Branch B (forming) of the subordinate hierarchy.

The computed positive transfer indexes indicated that students assigned to the NV + V_c treatment group had difficulty achieving the upper subordinate levels, especially in Branch B of the hierarchy. The range of the indexes was from .62 through .96 .

The results of pilot study number one were used to make changes in the subordinate hierarchy, instructional procedures, tests, and procedure for administering the tests. The changes involved (a) eliminating subordinate tasks concerned with conduction and convection, protruding and recessed molds, and draft; (b) simplifying Branch B of the subordinate hierarchy; (c) developing charts to be used to define sheet; (d) constructing a plastic cylinder to demonstrate the use of vacuum and air to stretch a material; (e) developing charts to emphasize the effect different heat intensities have on thermoplastic plastic sheets; (f) identifying more explicit instructional procedures for developing interrelationships between upper subordinate tasks; (g) writing new test items for the learning achievement test; (h) revising the final and transfer task tests; and (i) recording the transfer and learning achievement tests on audio tape. The revision made in the final task test required students to identify and order attributes of thermoforming from a word list. The descriptions of thermoforming and non-thermoforming procedures used on the transfer task were simplified. A sixth grade vocabulary list was used in the selection of words to describe the different processes.

Pilot Study Number Two

Pilot study number two involved 75 students enrolled in seventh and eighth grade industrial arts classes. The NV + V_c lesson was administered to one seventh and one eighth grade class. The second seventh grade class was administered the NV + V_s lesson. The fourth class was not presented a lesson.

The evaluation of the lesson identified (a) that the introduction of the lesson caused confusion, (b) that the equipment used to demonstrate the use of vacuum and air to stretch a material still needed to be reconceptualized, and (c) that the students had to be better informed about the nature of the performance expected of them.

Again, student performances on the final task and transfer tests indicated that the students did not achieve the upper subordinate levels or the tests were not functioning as expected (Final task treatment means: NV + V_c = 7.61, NV + V_s = 6.03, no-treatment = 6.88, chance = 7.00; Transfer test treatment means: NV + V_c = 3.30, NV + V_s = 2.12, no-treatment = 2.68, chance = 3.00). On the final task, the students checked all the attributes in the word list they were familiar with, regardless of how well they understood them.

The D.I., Disc. I., and discrimination curves signified that 4 out of 31 items were not adequate. Two of the learning achievement test items were related to the same subordinate task.

The use of audio tape to administer the tests had an effect on student performances. Students in one class assigned to the NV + V_c treatment were matched by pairs according to their reading ability.

While one member listened to the audio tape as he completed the transfer test, his partner read the test. The treatment was reversed for the learning achievement test. Students who listened to the tape averaged six points higher on the learning achievement test and two points higher on the transfer test.

The researcher observed that students exchanged information when the same junior high school was used to administer different treatments. This was especially obvious during the three days of testing.

Positive transfer indexes indicated that Branch A (thermo) was relatively effective (Positive indexes = .82, .82, .62, .94, .81, .93, 1.00). The researcher assumed that the .62 occurred because of faulty instruction.

The indexes for Branch B (forming) indicated further refinement was needed (Positive indexes = .71, .86, .65, .68, .65, .67, .76, .79). The students assigned to the $NV + V_C$ treatment had not developed an understanding of the difference between using air or vacuum to stretch a material compared with the use of air or vacuum to hold a material against a mold.

Revisions made for conducting pilot study number three involved (a) eliminating subordinate tasks concerned with the definition of mechanical pressure and the effect heat had on different materials, (b) identifying the use of air and vacuum to stretch a material and the use of air and vacuum to hold a material against a mold as subdivisions of Branch B, (c) developing overlays and handout sheets to identify the performances expected of the students, (d) developing programmed instructional procedures for presenting each subordinate task, (e) rewriting test items for the learning achievement test, (f) constructing a programmed decision-making final task test, (g) revising the transfer test, and (h) recording the transfer and learning achievement tests on audio tape.

The revision made in the instructional procedure for defining the performance expected of the students assigned to the $NV + V_c$ and V treatments involved (a) defining the purpose of the learning task diagram (subordinate hierarchy), (b) identifying that each task interrelates and "builds" upon lower adjacent tasks, and (c) that the interrelationship among the tasks would enable them to solve a problem. Copies of the learning task diagram were made for the students.

The programmed instructional procedure developed consisted of (a) using an overlay to project a question on the screen, (b) reading the question, (c) answering the question verbally, (d) explaining or demonstrating the answer to the question depending upon the treatment, (e) asking other appropriate questions related to a subordinate task in the same manner as identified in (a) through (d), (f) projecting the subordinate task on the screen with words missing, (g) requiring the students to fill in the blanks of the statement on their handout sheets, and (h) projecting and reading the answer to the students. The procedure was repeated for each subordinate task.

The programmed decision-making final task test required students to make a response to a multiple-choice item. The student's answer directed him to the next question to be answered. The students were instructed to make decisions that would result in them identifying a procedure for making a thermoformed product. The total of possible points on the test was 9.

Pilot Study Number Three

Pilot study number three consisted of 70 students enrolled in 4 seventh and eighth grade industrial arts classes. Each class was randomly assigned to either the NV + V_c, V, NV + V_s, or no-treatment group.

The transfer test was revised by providing more explicit directions, simplifying the descriptions of the thermoforming and non-thermoforming procedures, and listing possible reasons for marking an item false.

The results of the pilot study identified that the NV + V_c treatment group did better than the rest of the treatment groups on the three tests. (See Table 5.) Chance scores for the transfer and learning achievement tests were 3.50 and 8.75, respectively. Students with total scores below 3.00 on the final task test had not made decisions that resulted in them using thermoforming to produce a product.

Table 5. Pilot Study Number Three--Student Performances Per Treatment on the Final Task, Transfer, and Learning Achievement Tests

Treatment	Final Task Test		Final Task Test $\bar{x}$	Transfer Test $\bar{x}$	Learning Achievement Test $\bar{x}$
	No. Selected Thermoplastic Route	% Selected Thermoplastic Route			
No	1 out of 16	6.25	.50	3.00	13.56
NV + V_s	0 out of 15	0.00	1.50	4.00	15.20
V	8 out of 22	36.4	2.50	5.52	19.45
NV + V_c	13 out of 17	76.5	4.76	6.26	20.66

D.I., Disc. I., and discrimination curves were determined. Six items did not have adequate characteristics to be used in their present form. Most of these items were related to the upper subordinate hierarchical tasks. The tasks were concerned with the development of mental processes for interrelating concrete and/or relational concepts of thermoforming.

A chart was developed to identify variables which were affecting student performances on each test item. The results indicated that the NV + V_c lesson did not include instruction related to three subordinate tasks. The V lesson did not include instruction related to two tasks. Also, test items that were written to test upper subordinate level tasks were actually testing lower subordinate tasks. Six test items were identified as being easy. These items were located at the lower subordinate levels.

Computed positive transfer indexes for the NV + V_c and V treatment indicated that over half of the students in the NV + V_c treatment group achieved the upper subordinate levels and that very few students in the verbal treatment group achieved the upper subordinate level. Composite transfer indexes for the two treatments ranged from .64 through .96 ($\bar{x}$ = .80). The mean for Branches A and B were .82 and .77, respectively.

The results of the pilot study indicated (a) that the subdivisions of holding and stretching in Branch B of the hierarchy should be simplified, (b) that upper subordinate tasks should place more emphasis on interrelating Branches A and B, (c) that further refinement of the final task test was needed, (d) that the students were better informed about performances expected of them, (e) that the programmed instrucational procedure interrelated adjacent level subordinate tasks, (f) that explicit directions for taking the final task test had to be developed, and (g) that test items at the upper subordinate levels had to be written to measure specific intellectual processes.

Since the results of pilot study number three indicated no major changes in the subordinate hierarchy and instructional procedures, the researcher decided to write the scripts for video taping the NV + V_c, V, and NV + V_s lessons. The refinements indicated were incorporated in the writing of the scripts.

Video Taped Lessons

The video tape medium for presenting the NV + V_c, V, and NV + V_s lessons was utilized to control differences between treatments, teaching ability, and teacher expectations. The video tape medium was selected because it could be shown in a classroom while the lights were on. Limitations associated with the use of the medium were (a) the artificiality of the video tape as compared with the normal classroom, (b) the reduction of the number of senses used by the students to perceive transmitted information, and (c) the requirement that both the nonverbal event and environmental context of the event be recorded.

The procedure for producing the video tapes involved (a) refining the subordinate hierarchy, (b) redefining the purpose of the NV + V_s treatment, and (c) writing, evaluating and taping the NV + V_c, V, and NV + V_s lessons.

The scripts and tapes were evaluated by a committee to insure the optimum use of the medium and to determine the equality of the three video taped lessons. Optimum was operationally defined by using the medium to depict normal classroom procedures. Thus, techniques such as split-screen, slow motion, or stop action were not used. Secondly, optimum was defined as use of the best personnel and techniques available to depict normal classroom procedures. Equality was defined as the use of the same equipment, personnel, and techniques for taping all three lessons.

Refinement of the Subordinate Hierarchy

Refinements made resulted in the subordinate hierarchy consisting of 13 tasks. (See Appendix F, pp. 212 - 214 .) The revisions involved stating precisely each hierarchical task and simplifying Branch B. The revisions were based upon the findings of pilot study number three.

Refinements in the behavioral objectives per superordinate level and subordinate task were made to reflect changes in the hierarchy. (See Appendix G, pp. 215 - 220.) The objectives were used to plan the instructional procedure for the NV + V_c and V scripts, and to develop the Learning Tasks Sheet. (See Appendix H, pp. 221 - 224.) This sheet was completed by students randomly assigned to the NV + V_c and V treatments.

Refinement of the NV + V_s Lesson

The NV + V_s lesson was administered in pilot studies two and three to depict the "learning by doing" approach. The purpose of the lesson in pilot study number two was: The students will be able to identify how to construct a thermoformed product. This objective was changed for pilot study number three to: The students will be able to identify how to vary the procedure for constructing a thermoformed product to produce other similar thermoformed products. The objective was changed (a) to depict the students acquiring a higher level of understanding of how to construct a thermoformed product and (b) to include the major attributes of thermoforming as specified for the NV + V_c and V lessons. (See Appendix G, p. 216.)

The selection of products to be constructed was based upon thermoforming processes that are usually completed by seventh and eighth grade industrial arts students. The processes selected were draping, bending, and stretching thermoplastic plastic sheets.

Production of Video Tapes

Each script was prepared by utilizing the same story-board format. This format involved listing the video portion of the script on the left-hand side of the page and the audio portion on the right-hand side.

The same introduction was employed for each script. The introduction was designed to create the necessary dissonance that would result in students watching the video tape (Waetjen, 1964). The introduction involved showing students different thermoformed products they could make. A brief description of each product was included so that they would be able to relate to them. This approach proved to be effective for administering pilot study number three.

The NV + V_c and V scripts incorporated the procedure used in pilot study number three to define the expected performance of the students. (See Appendices I and J, pp. 225-263 and 264-301.) The purposes of the Learning Task Diagram and the Learning Task Sheet were explained to the students. (See Appendices F and H, p. 213 and pp. 221-224.) Next, the students were informed how the lesson was going to be presented.

The procedure for presenting each task involved specifying the task to be completed. This was followed by a question that was shown on the screen and read by the narrator. Next, the question was answered verbally. The answer was demonstrated in the NV + V_c script. For the V lesson, the demonstration was described verbally. If another question was asked, related to the same task, the procedure was repeated.

After a brief summary, the students were requested to complete the learning task. The task was shown on the screen. After a brief pause, the answer was shown on the screen and read by the narrator.

A summary of the completed tasks was included after each hierarchical branch. The summary involved showing the learning task diagram, specifying the tasks completed, and describing the tasks completed.

The conclusion of the NV + V_c and V scripts was completed in the same manner as the summary for each subordinate branch. The conclusion of the NV + V_c, V, and NV + V_s lessons informed students about the performance expected of them during the test phase of the study.

The NV + V_s script described the procedure for constructing a candy dish, a napkin holder, and a small bowl. (See Appendix K, pp. 302 - 330.) Each step used to construct the candy dish was shown on the screen. These steps were included in a handout. (See Appendix L, pp. 331 - 337.)

The means used to adapt the procedure for constructing the candy dish was shown on the screen during the construction of the napkin holder and small bowl. The thermoforming process used to produce each product was emphasized.

After the scripts were written, they were evaluated by five West Virginia University faculty members. The faculty were selected for their familiarity with the purpose of the study and Gagné's learning paradigm. Their recommendations were incorporated into the scripts.

Next, the production of the tapes was scheduled. The services of the West Virginia University Educational Television Station were contracted for one week. A radio news-and-sports commentator was hired to narrate the tapes. The researcher was the actor for the nonverbal medium in the $NV + V_c$ and $NV + V_s$ lessons.

The taping was done in a TV studio designed for black-and-white production. The production involved the use of three cameras and two 7800 high-low band, one-inch, Ampex tape recorders. The personnel consisted of three cameramen, one technician, two console operators, one video tape operator, and one production director.

The same camera techniques, lighting, placement of equipment, personnel, director, narrator, and actor were used for making each tape. Also, each tape was rehearsed at least once with the cameras on. After each take, the tape was evaluated by the director, the researcher, and the narrator. All editing was completed before another tape was made.

Care was taken to make sure that each video tape was the same length. The $NV + V_c$ tape was 40-1/2 minutes long. The V was 42-1/4 minutes long, and the $NV + V_s$ tape was 41-1/2 minutes long.

The tapes were shown to the five university faculty members who evaluated the scripts. They approved the use of the video tapes for conducting the final study.

Reliability of Tests

A fourth pilot study was conducted to determine the reliability of the three tests. Item to total score correlations were computed for each learning achievement test item. The homogenity of the learning achievement test was determined by computing KR_{20}. Test-retest correlations were computed for all three tests.

The preparation of materials for conducting the fourth pilot study involved (a) revising the tests, (b) developing a programmed instruction booklet for the final task test, (c) writing instructions for teachers to administer the tests, and (d) making audio tapes for administering the transfer and learning achievement tests.

The learning achievement test was altered to include three or four items per subordinate task. This was executed to insure that two items per task were identified for conducting the final study. Most of the items that were used to conduct pilot study number three were included in the revised edition of the learning achievement test. (See Question Section of Appendix M, pp. 338 - 356.) The test consisted of 47 items.

A programmed instruction booklet was written to inform the students how to take the programmed decision-making final task test. The results of pilot study number three indicated that the researcher had to depend upon test instructions to insure that the students understood how to take the final task test.

A script was written for recording the introduction of the programmed instruction booklet, the transfer and the learning achievement tests. The narrator of the video tapes recorded the audio tape. A monotone voice was used to read each test item.

The pilot study was conducted in four schools involving 6 seventh and eighth grade industrial arts classes. The schools were randomly assigned to the $NV + V_c$, V , and $NV + V_s$ treatments. The high school assigned to the $NV + V_c$ treatment was located in a rural, coal mining community. The V treatment involved students enrolled in a city high school and a rural high school. The junior high school assigned to the $NV + V_s$ treatment was located in a rural community. The number of students per treatment was: $NV + V_c = 38$, $V = 37$, $NV + V_s = 38$.

The video tapes were administered by the researcher. The Learning Task Diagram and Learning Tasks Sheets were handed out to students assigned to the $NV + V_c$ and V treatments before the tapes were shown. (See Appendices F and H, p. 213 and pp. 221-224.) The students completed the learning tasks while they observed the lesson. The plan sheet was handed out to students assigned to the $NV + V_s$ treatment. (See Appendix L, pp. 331-337.)

The industrial arts teachers administered the tests on two consecutive days during the industrial arts class periods. The final task test was administered first, followed by the transfer and learning achievement tests. Two weeks later the three tests were administered again. The researcher visited most of the teachers while they administered the tests the first time. Problems in scheduling resulted in the transfer test not being given to one V treatment class during the test and retest situation.

A list of recommendations regarding the administration of the tests was solicited from the teachers. The recommendations were (a) that each test be numbered, (b) that a check list of operations be provided, (c) that teachers become familiar with the test materials before administering them, (d) that all test materials be recorded on one side of the audio tape, (e) that students be informed about the study three or four days before it is conducted, (f) that the programmed instructions for the final task test be revised, and (g) that the students do not complete the learning tasks sheets while they watch the tape.

The learning achievement test items were evaluated. Discrimination curves, D.I., and Disc. I. per item were determined. Product-moment correlations were computed between each item and total score. (See Appendix M, pp. 338 - 356.) Items with item-score correlations above .24 were identified as possible questions for conducting the final study. (See Appendix M, p. 357.) The use of test items with correlations above .30 would have resulted in no items being identified for tasks number 10, 11, and 12. The correlations ranged from .24 through .54 .

The internal consistency of the learning achievement test was determined by computing KR_{20}. The formula used was:

$$r = \frac{k}{k - 1} \quad 1 - \frac{\sum pq}{\sigma^2}$$

$$\sigma^2 = [\sum x^2 - (\frac{(\sum x)^2}{n})] / (n - 1)$$

k = number of questions used

n = number of items

Correct and incorrect student responses for the 29 items with item-total correlations above .24 were used to compute KR_{20}. The KR_{20} coefficient was .86 for the pre-test. A coefficient of .88 was computed for the post-test.

Product-moment correlations were computed between pre- and post-test scores for the learning achievement, final task, and transfer tests. The test-retest correlation for the learning achievement test was .89 . A .82 correlation was computed for the transfer test . The correlation between pre- and post-final task tests was .70 .

Positive transfer indexes were computed for each adjacent higher-lower subordinate task for the NV + V_c and V treatment groups. (See Table 6.) Student performances on the 29 items with item-score correlations above .24 were used. (See Appendix M, p. 357.) No test items with correlations above .24 were identified for task number 13.

Table 6. Positive Transfer Indexes Between Adjacent Subordinate Tasks for Students Assigned to the NV + V_c and V Treatments in Pilot Study Number Four

	Adjacent Tasks Examined	Test Items per Tasks Examined	(1) ++	(2) --	(3) -+*	(1+2) / (1+2+3)	Positive Transfer Index
A	1: 3	1,2: 9,10,11	39	9	4	48/52	.92
	2: 3	5,6,7: 9,10,11	34	16	9	50/59	.85
	3: 4	9,10,11:13,14,15	25	16	13	41/54	.72
	3: 5	9,10,11:17,18	18	25	4	43/47	.91
	4:12	13,14,15:41,43	12	28	6	40/46	.87
	5:13	17,18,19:-- --	--	--	--	-----	---
B	6: 7	20,21,22:24,25,27	24	21	12	45/57	.79
	8: 9	28,29,30:31,32,33	7	38	11	45/56	.80
	7:10	24,25,27:36	17	30	6	47/53	.8[illegible]
	7:11	24,25,27:39	10	31	25	41/66	.62
	9:10	31,32,33:36	20	21	15	41/56	.73
	9:11	31,32,33:39	15	31	1	46/47	.98
	10:12	36:41,43	8	41	15	49/64	.77
	11:13	39:-- --	--	--	--	-----	---

* The +- pattern used by Gagné was changed to a -+ pattern since the tasks are listed from the lowest to the highest subordinate level.

A + was assigned to each subordinate task when students passed one out of one test item, two out of two test items, or two out of three test items related to a specific task. The majority of the students achieved the third superordinate level in the thermo branch of the hierarchy. The indexes ranged from .62 through .98 ($\bar{x}$ = .82). The means for the NV + V_c and V treatment groups were .86 and .80, respectively.

Collection of Data

Establishing instructional guidelines that would have general application for industrial arts teachers resulted in using different research procedures than Gagné and associates. The design of the study consisted of randomly assigning classes from a county school system to one of the four treatment groups. The no-treatment, or fourth treatment group, was added to determine previous verbal learning (PVL) the students had acquired about thermoforming.

The study was conducted at the junior and senior high school levels. The latter was executed to investigate the effect mental and language maturation had on student performances. The data collected at the junior and senior high school levels were student performances on the three tests and personal information from the students' permanent record cards.

A workshop was conducted for all teachers involved in the study after the treatments had been administered. At this time, the teachers were given details about the nature and design of the study.

Collection of Junior High Data

The county system included 22 junior high schools. Permission was secured from 18 junior high principals to conduct the study in their schools. Twenty-seven out of 29 industrial arts teachers volunteered to participate in the study. During the 1971-72 school year, the 27 teachers had approximately 207 seventh and eighth grade industrial arts classes with a total enrollment of 2,852 boys. All boys in the county school system were required to take industrial arts at the junior high level.

Each of the 18 schools was randomly assigned to the $NV + V_c$, V , $NV + V_s$ and PVL treatments (5, 5, 4, 4 schools, respectively). Sixteen seventh and eighth grade classes were randomly assigned to each treatment group for conducting the study. The 64 classes consisted of approximately 920 students. (See Appendix N, pp. 358 - 363.) Faulty data and teacher absences reduced the number of classes to 14, 15, 15, and 16, respectively. Student absences further reduced the number to 761 boys. The number of students per treatment was: $NV + V_c = 202$, $V = 189$, $NV + V_s = 161$, and $PVL = 209$.

The treatments were administered from February 15 through March 16, 1972. The teachers were informed which of their classes had been randomly selected. Three or four days before the treatments were administered, the teachers were requested to read a memorandum to their students.

Next, the teachers showed a video tape or administered the tests, depending upon the treatment. For the $NV + V_c$ and V treatments, the Learning Task Diagram was handed out to the students.

(See Appendix F, p. 213.) During the second industrial arts class period the Learning Tasks Sheet was completed by the students. (See Appendix H, pp. 221 - 224.) During the same period the students completed the final task programmed instruction booklet and the final task test. (See Appendices O and P, pp. 364 - 376 and 377 - 393.) The transfer and learning achievement tests were administered during the third class period. (See Appendices Q and R, pp. 394 - 400 and 401 - 409.) For most schools, students were assigned to take industrial arts during one class period per day.

For the NV + V_s treatment, the plan sheet was handed out before the video tape was shown. (See Appendix L, pp. 331 - 337.) In the following two class periods the programmed instruction booklet and tests were administered. The classes assigned to the PVL treatment were administered the tests. All test materials and instructions, except for the final task test, were recorded on audio tape.

The researcher provided the equipment and test materials for each teacher. The preparation of the materials involved (a) cleaning the video tape recorder; (b) making sure the video tape recorder and monitor were functioning properly; (c) assembling instructional booklets for teachers per treatment group; (d) counting programmed instruction booklets, test booklets, answer sheets, and handout sheets; and (e) assigning the correct audio and video tapes per teacher per treatment. The instruction booklets for the teachers were assembled by ordering instructional sheets for each activity to be completed per treatment. (See Appendix S, pp. 410 - 428.) Each instructional sheet was coded (1 = NV + V_c, 2 = V, 3 = NV + V_s, 4 = PVL). Care was taken to make sure the teachers did not know which treatments they were assigned.

Each teacher received personal instruction from the researcher for administering the treatments. The visitations were scheduled during the teachers' planning periods. The researcher stressed the need for the teacher to listen to the audio tape and read through the instructional booklet and test materials before administering the treatment.

Personal data were collected from the students' permanent record cards to determine which variables were related to student performances on each test. Fifty percent of the students were randomly sampled from each treatment group by the use of a random number table.

The data collected consisted of the student's address, grades, IQ score, achievement test scores, and parents' occupations. (See Appendix T, pp. 429 - 430.) The seventh grade students were administered the Educational Development Series Test Battery during the sixth grade. Subtests of the battery were nonverbal, verbal, reading, English, mathematics, science, U.S.A., and solving problems. An IQ score was computed by using chronological age and nonverbal and verbal scores. A total ability score was derived by adding the nonverbal and verbal scores. Reading, English, and mathematics scores were summed to determine a basic skills score.

The eighth grade students were administered the Stanford Achievement Test Battery during the sixth grade. Subtests of the Battery were word meaning, paragraph meaning, spelling, language, arithmetic comprehension, arithmetic concepts, arithmetic application, social studies, and science. The results of both achievement test batteries were computer printouts attached to student record cards.

The occupations and street address of the parents were used to assign social status. In 1962, the Kanawha County Planning and Zoning Commission received a grant to develop a comprehensive County Highway Plan (Kanawha, 1964a). Social-economic data was collected for determining the future location of highways in the county.

The data was based upon the 1960 census reports. The census material was verified and updated by checking building records, new utility services installed, changes in school attendance, employment security data, and random sampling of different residential areas.

The socio-economic data collected was used to assign a status level to the 343 county traffic zones. A status of I, II, III, IV, or V was assigned to each road zone by using the following code:

$$\left.\begin{array}{lll} \text{I :} & \$\ \ \ \ \ \ \ 0 & - \ \$\ 2{,}999 \\ \text{II :} & \$\ \ 3{,}000 & - \ \$\ 4{,}999 \\ \text{III:} & \$\ \ 5{,}000 & - \ \$\ 6{,}999 \\ \text{IV :} & \$\ \ 7{,}000 & - \ \$\ 9{,}999 \\ \text{V :} & \$\ 10{,}000 \text{ and up} & \end{array}\right\} \begin{array}{l}\text{Income per} \\ \text{Household Unit}\end{array}$$

The procedure used to assign student status involved determining the road zone number in which the student lived. This was accomplished by consulting a street directory (Kanawha, 1964b). A table was used to determine the status of the road zone. Mail route maps were used to determine road zone numbers for students who lived in rural areas.

The status of some students was changed by the researcher when a discrepancy occurred between the parents' occupations and the status assigned to the area in which the parents lived. A list of occupations per zone and the location of new residential areas since 1964 were used as guides for changing status.

Collection of Senior High Data

The study was conducted in four senior high schools during the week of March 13 through 17, 1972. Each school was randomly assigned to one of the four treatment groups. The sample consisted of boys an girls enrolled in required biology courses, advanced biology courses, and mechanical drawing courses.

The NV + V_c treatment included two biology classes of 57 students and three mechanical drawing classes of 57 students. Student absences reduced the number to 96. Sixty-four students in three biology classes and 36 students in two mechanical drawing classes were involved in the V treatment. Problems in scheduling and student absences reduced the number to 60. The NV + V_s treatment included three biology classes of 75 students and two mechanical drawing classes of 49 students. Data were collected for 106 students. Two biology classes of 50 students and three mechanical drawing classes of 28 students were assigned to the PVL treatment. Absences reduced the total number of students to 66. The biology classes for each treatment consisted of required and advanced courses. Each treatment involved tenth, eleventh, and twelfth grade students. The total number of students per treatment was: $NV + V_c = 96$, $V = 60$, $NV + V_s = 106$, and $PVL = 66$.

The same procedure used at the junior high level was utilized to administer the treatments at the senior high level. Changes consisted of (a) having the $NV + V_c$ and V treatments complete the Learning Tasks Sheet while the video tape was being shown (See Appendix H, pp. 221 - 224), (b) not using the programmed instruction booklet and having the teachers explain the directions for the final task test, and (c) not using the audio tape for administering the transfer and learning achievement tests. The researcher provided personal instruction, equipment, and test materials for each senior high school teacher.

Personal data were collected from 50% of the students assigned to each treatment group. The data collected were the same as the junior high data, except the senior high students had taken both the Educational Development Test Battery (EDS) and the Stanford Achievement Test Battery (SAT). (See Appendix U, pp. 431 - 433.) The IQ tests and SAT were administered during the 6th grade for all tenth, eleventh, and twelfth grade students. The EDS was administered during the ninth grade for tenth grade students, during the ninth or eleventh grade for eleventh grade students, and during the eleventh grade for twelfth grade students.

The procedure used to determine the social status of junior high school students was used for senior high school students.

Procedure Used for Analyzing Data

The personal data collected for students assigned to the NV + V_c, V, and NV + V_s treatments and their performances on the final task, transfer, and learning achievement tests were used to test the three hypotheses. Each hypothesis was tested by using first the junior high data and second the senior high data.

The first hypothesis tested was:

> The students' amount of abstract understanding of a pre-selected technical concept taught by the use of the verbal instructional medium complementing the nonverbal instructional medium (NV + V_c) will be equal to the mean level of abstract understanding of students who have been taught by the use of the verbal instructional medium (V) or the V instructional medium supplementing the nonverbal instructional medium (NV + V_s).

A one-way analysis of variance was used to determine the difference of the mean performances of the three treatments on the final task test and the transfer test. Duncan's multiple range test was used to determine significant differences between treatment means.

The second hypothesis tested was:

> On the learning achievement test, the mean performance of the NV + V_s, V, and NV + V_c instructional media treatments will be equal.

The learning achievement treatment means were analyzed by using one-way analysis of variance. Differences among means were determined by using Duncan's multiple range test.

The third hypothesis tested was:

> The treatment would not be a significant factor in the prediction of learning capability scores when combined with IQ, standardized achievement test scores, grades in previous courses, and socio-economic status.

A step-wise multiple regression analysis was utilized. The regression was continued until the variable entering the prediction equation did not account for a significant proportion of the total sum of squares.

CHAPTER IV

ANALYSES OF DATA

The analyses of data were conducted in three phases. Each phase was concerned with testing hypothesis one, two, or three. The three phases were used to analyze first, the junior high data, and second, the senior high data. If the testing of hypothesis number two revealed significant differences among treatments, additional procedures were utilized to identify the difference. Finding differences among the three instructional treatments was considered more significant than finding differences between instruction and no-instruction.

Analyses of Junior High Data

The analyses of junior high data were conducted using 60 classes of seventh and eighth grade boys enrolled in industrial arts. Classes and number of students per treatment were: $NV + V_c = 14$ classes, 202 students; $V = 15$ classes, 189 students; $NV + V_s = 15$ classes, 161 students; and PVL = 16 classes, 209 students. Personal data were collected for 50% of the students. These data were used to test the third hypothesis.

Hypothesis Number One

The null hypothesis tested was that the amount of abstract understanding of a pre-selected technical concept taught by the use of the $NV + V_c$ instructional media will be equal to the mean level of abstract understanding of students who have been taught by the V instructional medium and the NV + V_s instructional media. One-way analysis of variance and Duncan's multiple range tests were used to examine this hypothesis.

Class performances on the final task and transfer tests were used to measure the amount of abstract understanding the students had acquired from each treatment group. (See Appendices P & Q, pp. 377-393 and 394-400.) Significant differences were determined by comparing the NV + V_c, V , NV + V_s, and PVL treatment means for each test. No significant differences were determined among any of the instructional treatments.

Class means and variances were used to assess student performances on the final task test. (See Table 7.) The mean for the NV + V_c treatment classes was 3.8, with a standard deviation of 2.1. Class averages ranged from 1.3 through 7.9 . The range of the class averages for the V treatment was 0.8 through 5.9 . The treatment mean and standard deviation were 3.5 and 1.4, respectively. The mean for the NV + V_s treatment was 3.1 . The standard deviation was .95 . The class averages ranged from 1.5 through 4.7 . The mean for the PVL treatment classes was 1.8 with a standard deviation of .50 . The range was 0.9 through 2.7 .

The analysis of variance was conducted using the four treatment groups. (See Table 8.) A significant difference was detected between the variance among treatments as compared with the variance within treatments ($\alpha = .01$) .

Table 7. Treatment Means and Variances for Each Junior High Class Performance on the Final Task Test

No. of Classes	Treatments											
	$NV + V_c$			V			$NV + V_s$			PVL		
	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.
1	11	5.4	4.8	15	4.0	3.6	10	2.3	2.6	12	2.0	1.3
2	13	2.3	3.2	17	4.4	4.0	[illegible]	3.2	2.7	5	2.2	1.9
3	16	5.9	4.2	9	5.9	3.9	9	2.8	2.8	7	1.6	1.1
4	18	1.4	2.5	9	2.7	3.4	10	3.8	2.3	19	2.7	2.6
5	16	7.9	3.8	11	4.1	4.4	13	1.5	2.2	17	1.8	1.5
6	19	2.6	3.7	12	2.4	2.9	14	3.9	2.0	19	2.5	1.5
7	12	1.3	3.2	12	5.8	5.0	13	4.0	2.1	19	1.8	2.4
8	11	3.3	4.5	16	3.4	3.5	12	3.8	2.3	21	2.0	2.1
9	14	2.9	3.5	16	3.1	3.9	10	3.3	2.5	16	1.6	1.2
10	21	7.2	3.9	11	4.4	4.8	10	4.1	2.1	11	1.6	1.4
11	10	4.5	3.5	11	2.3	3.1	9	2.3	2.2	16	2.6	1.9
12	16	2.1	3.8	12	1.0	2.4	9	1.9	2.4	10	0.9	1.2
13	13	3.5	3.8	14	3.3	3.7	13	2.0	2.3	10	1.3	1.2
14	12	3.4	3.9	11	0.8	1.5	11	3.5	2.3	9	1.4	1.1
15				13	4.5	4.4	9	4.7	1.0	9	1.2	1.6
16										9	1.6	1.2
Mean of Means*		3.8			3.5			3.1			1.8	
S.D. of Means		2.1			1.4			.95			.50	

* Unit of Analysis is means

Table 8. Analysis of Variance of Junior High Student Performance on the Final Task Test Involving Four Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	3	37.54	12.51	6.84*
Within	56	102.44	1.83	

* Significant at the .01 level ($F_{.01}$; 3, 56 = 4.16)

Table 9. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Four Junior High Treatment Means on the Final Task Test

Treatment	PVL	NV + V_s	V	NV + V_c
Mean	1.8	3.1	3.5	3.8*

* Any two means not underscored by the same straight line were significantly different (α = .05)

Significant differences among treatment means were determined by using Duncan's multiple range test. (See Table 9.) The NV + V_c, V , and NV + V_s treatment means were each significantly different from the PVL mean ($\alpha = .05$) . The NV + V_c, V , and NV + V_s treatments were not significantly different from each other. The means were: NV + V_c = 3.8, V = 3.5, NV + V_s = 3.1, and PVL = 1.8 .

Student performances on the transfer test were summarized by computing class means and standard deviations. (See Table 10.) The means for the NV + V_c, V , NV + V_s, and PVL treatments were 8.0, 8.0, 7.4, and 5.0, respectively. The standard deviations treatment means were 1.6, 2.5, 1.6, and 1.2 . The range of the class averages were: NV + V_c = 5.2 through 10.8, V = 3.5 through 12.3, NV + V_s = 5.4 through 10.7, and PVL = 2.8 through 7.3 .

Since no significant difference was determined between the variance among the three instructional treatments as compared with variance within instructional treatments, the one-way analysis of variance was conducted using the four treatment groups. (See Table 11.) A significant difference was detected at the .01 level.

Duncan's test was used to determine significant differences among treatment means. (See Table 12.) The PVL treatment mean was significantly different from the NV + V_c, V , and NV + V_s means ($\alpha = .05$) .

Table 10. Treatment Means and Variances for Each Junior High Class Performance on the Transfer Test

No. of Classes	Treatments											
	$NV + V_c$			V			$NV + V_s$			PVL		
	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.
1	11	8.4	5.4	15	8.1	3.1	10	6.1	2.5	12	4.3	1.8
2	13	6.3	2.9	17	12.2	5.4	9	10.6	2.7	5	2.8	1.1
3	16	10.8	5.4	9	9.2	6.3	9	8.2	4.3	7	4.9	1.6
4	18	9.0	4.0	9	6.7	6.0	10	8.0	2.7	19	4.2	2.0
5	16	10.6	5.6	11	10.1	4.5	13	10.7	2.5	17	4.6	2.2
6	19	7.5	2.7	12	5.5	3.4	14	6.6	2.6	19	4.2	2.0
7	12	8.3	3.6	12	12.3	7.3	13	8.7	3.1	19	6.7	3.9
8	11	5.2	2.3	16	7.8	3.7	12	5.8	2.4	21	5.0	1.8
9	14	6.4	2.3	16	6.2	3.9	10	6.8	2.0	16	4.6	1.7
10	21	9.4	4.5	11	11.0	6.9	10	5.4	3.6	11	4.1	2.3
11	10	9.0	2.4	11	5.7	2.7	9	6.8	1.5	16	7.3	3.4
12	16	9.3	5.1	12	5.9	3.5	9	7.9	3.0	10	5.9	2.6
13	13	6.8	3.4	14	7.2	2.1	13	6.5	2.5	10	4.2	1.6
14	12	5.2	2.9	11	3.5	2.8	11	6.2	1.8	9	5.0	1.8
15				13	8.0	5.3	9	7.4	4.4	9	6.9	1.8
16										9	5.2	2.5
Mean of Means*		8.0			8.0			7.4			5.0	
S.D. of Means		1.6			2.5			1.6			1.2	

* Unit of Analysis is means

Table 11. Analysis of Variance of Junior High Student Performance on the Transfer Test Involving Four Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	3	102.79	34.26	10.54*
Within	56	182.11	3.25	

* Significant at the .01 level ($F_{.01}$; 3, 56 = 4.16)

Table 12. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Four Junior High Treatment Means on the Transfer Test

Treatment	PVL	$NV + V_s$	V	$NV + V_c$
Mean	5.0	7.4	8.0	8.0*

* Any two means not underscored by the same straight line were significantly different (α = .05)

The analyses of junior high student performances on the final task and transfer tests identified no significant differences among the three instructional treatment means. Thus, the null hypothesis was accepted. Significant differences were determined between instruction and no-instruction.

Hypothesis Number Two

The null hypothesis tested was that the mean performance of the NV + V_c, V , and NV + V_s treatments on the learning achievement would be equal. The learning achievement test was utilized to measure the amount of verbal knowledge the students had acquired. (See Appendix R, pp. 401 - 409.) The means of the three instructional treatment groups were used in determining significant differences.

The class means and standard deviations for the NV + V_c, V, NV + V_s, and PVL treatments were computed. (See Table 13.) The mean for the NV + V_c treatment was 19.6 with a standard deviation of 3.5 . The class averages ranged from 14.8 through 27.8 . The mean for the V treatment was 18.1 . The range was 13.5 through 21.9 . The standard deviation was 2.5 . The range for the NV + V_s class averages was 12.4 through 19.0 . The mean and standard deviation were 16.0 and 2.1, respectively. The mean for the PVL treatment was 14.9 with a standard deviation of 2.7 . The range was 8.2 through 17.9 .

A one-way analysis of variance was calculated using the variances among and within the three instructional treatment groups. (See Table 14.) Treatment was found to have a significant effect on student performances on the learning achievement test (α = .01).

Table 13. Treatment Means and Variances for Each Junior High Class Performance on the Learning Achievement Test

Class	Treatments											
	$NV + V_c$			V			$NV + V_s$			PVL		
	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.	n	$\overline{x}$	S.D.
1	11	22.1	7.3	15	16.7	5.1	10	15.7	3.8	12	14.2	3.4
2	13	16.2	7.2	17	21.3	6.7	9	18.4	5.8	5	17.8	3.3
3	16	21.4	6.7	9	21.9	4.3	9	18.1	4.4	7	10.3	2.7
4	18	18.2	7.5	9	13.7	2.9	10	19.0	4.1	19	16.4	3.1
5	16	22.5	4.6	11	16.7	5.8	13	16.7	3.5	17	13.6	5.3
6	19	17.0	5.2	12	16.8	6.0	14	14.8	5.8	19	14.8	2.0
7	12	22.0	3.7	12	19.0	7.6	13	17.3	4.8	19	17.2	6.6
8	11	19.6	5.8	16	20.0	5.7	12	16.4	4.3	21	15.0	5.7
9	14	15.4	4.5	16	17.6	5.4	10	12.4	6.1	16	14.7	3.5
10	21	27.8	3.3	11	21.8	7.0	10	14.1	5.5	11	8.2	3.5
11	10	18.7	4.7	11	18.2	5.1	9	13.3	3.9	16	17.5	3.8
12	16	20.7	4.0	12	18.3	4.3	9	13.0	2.7	10	14.6	5.2
13	13	14.8	5.2	14	17.1	4.7	13	15.8	4.3	10	14.6	4.4
14	12	17.4	3.7	11	13.5	3.2	11	16.9	4.1	9	17.4	5.4
15				13	18.9	6.7	9	18.4	3.9	9	17.9	4.9
16										9	14.9	4.6
Mean of Means*		19.6			18.1			16.0			14.9	
S.D. of Means		3.5			2.5			2.1			2.7	

* Unit of Analysis is means

Table 14. Analysis of Variance of Junior High Student Performance on the Learning Achievement Test Involving the Three Instructional Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	2	89.56	44.78	5.83*
Within	41	314.76	7.68	

* Significant at the .01 level ($F_{.01;\ 2,\ 41} = 5.17$)

Table 15. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Three Junior High Treatment Means on the Learning Achievement Test

Treatment	$NV + V_s$	V	$NV + V_c$
Mean	16.0	18.1	19.6*

* Any two means not underscored by the same straight line were significantly different ($\alpha = .05$)

Duncan's multiple range test was used to determine significant differences between the three treatment means. (See Table 15.) The NV + V_c treatment mean and V treatment mean were significantly different from the NV + V_s treatment ($\alpha = .05$). There was no significant difference between the NV + V_c and V treatment means. The means were: NV + V_c = 19.6, V = 18.1, and NV + V_s = 16.0.

Differences among student performances on the learning achievement test were further analyzed by (a) computing NV + V_c and V treatment positive transfer indexes, (b) determining the percentage of ++, --, -+, and +- patterns, (c) by plotting item discrimination curves for each test item per treatment group, and (d) determining major differences between positive transfer indexes, among ++, --, -+, and +- patterns, and among item discrimination curves.

The computation of positive transfer indexes required that the learning achievement test be analyzed. The performances of students assigned to the instructional treatment groups were used to plot item discrimination curves and calculate discriminate indexes, difficulty indexes, item-total score correlations, and the KR_{20} measure of test reliability. (See Appendices R & V, pp. 401-409 and 434 - 447.) The criteria previously identified in Chapter III were used to evaluate each item. The calculated difficulty indexes mean was .61. The range was from .29 through .89 . The easiest items were related to lower-level subordinate tasks. All of the item discrimination indexes were positive. The discrimination curves for questions 22, 27, and 28 were somewhat erratic. Item-score correlations ranged from .15 through .55 . Questions number 22, 27, and 28 were not utilized to calculate positive transfer indexes and the KR_{20} value. Item-total correlations ranged from .25 through .55 ($\bar{x}$ = 38.5). The computed value of KR_{20}, used to measure the internal consistency of the test, was .82 .

To determine differences between treatments, positive transfer indexes were computed for the NV + V_c and V treatments. (See Appendix V, p. 447.) (See Tables 16 and 17.) The positive transfer index mean for the NV + V_c treatment was .82 with a range from .65 through .90 . The mean for the V treatment was .80 . The range was .54 through .95 . Fifty-nine percent of the difference between the means was associated with Branch A of the hierarchy.

More enlightening differences among treatment groups were determined by comparing the percentage of ++, --, -+, and +- patterns. (See Table 18.) The average ++, --, -+, and +- patterns for each treatment group was divided by the number of students per treatment. The percentage of ++ patterns decreased while the percentage of -- patterns increased. The order of increase in ++ patterns was the same as the treatment means. The order of the -- patterns was the inverse of the order of the treatment means.

The analyses of item discrimination curves for each treatment group identified differences among student performances on the learning achievement test. Generally, the curves for the PVL treatment were erratic. Students assigned to the NV + V_s treatment had difficulty answering items concerned with (a) how changes in

Table 16. Positive Transfer Indexes Computed Between Adjacent Subordinate Tasks for Junior High Students Assigned to the NV + V_c Treatment

	Adjacent Tasks Examined	Test Items per Tasks Examined	(1) ++	(2) --	(3) -+	Positive Transfer Index*
A	1: 3	1,2: 6, 7, 8	85	34	65	.65
	2: 3	3,4,5: 6, 7, 8	125	28	25	.86
	3: 4	6,7,8: 9,10,11	111	24	28	.83
	3: 5	6,7,8:12,13	51	42	10	.90
	4:12	9,10,11:30,31	57	49	14	.88
	5:13	12,13:32,33	21	86	55	.66
B	6: 7	14,15,16:17,18,19	109	43	17	.90
	7:10	17,18,19:26	95	34	42	.75
	8: 9	20,21:23,24,25	90	39	37	.78
	9:10	23,24,25:26	57	28	9	.90
	9:11	23,24,25:29	19	121	15	.90
	10:12	26:30,31	31	96	40	.76
	7:11	23,24,25:29	59	53	12	.90
	11:13	29:32,33	127	43	32	.84

* (1 + 2) / (1 + 2 + 3)

Table 17. Positive Transfer Indexes Computed Between Adjacent Subordinate Tasks for Junior High Students Assigned to the V Treatment

	Adjacent Tasks Examined	Test Items per Tasks Examined	(1) ++	(2) --	(3) -+	Positive Transfer Index*
A	1: 3	1,2: 6, 7, 8	72	37	43	.72
	2: 3	3,4,5: 6, 7, 8	80	45	35	.78
	3: 4	6,7,8: 9,10,11	82	37	36	.77
	3: 5	6,7,8:12,13	36	56	17	.84
	4:12	9,10,11:30,31	33	61	9	.91
	5:13	12,13:32,33	14	67	68	.54
B	6: 7	14,15,16:17,18,19	83	45	21	.86
	7:10	17,18,19:26	68	50	34	.78
	8: 9	20,21:23,24,25	63	48	36	.76
	9:10	23,24,25:26	53	22	4	.95
	9:11	23,24,25:29	9	108	23	.84
	10:12	26:30,31	12	101	30	.79
	7:11	23,24,25:29	26	70	16	.86
	11:13	29:32,33	99	43	46	.76

* (1 + 2) / (1 + 2 + 3)

Table 18. Comparison of the Percentage of ++, --, -+, and +- Patterns Per Treatment Group of Junior High Student Performance on the Learning Achievement Test

Treatment	$\bar{x}$ ++/n	$\bar{x}$ --/n	$\bar{x}$ -+/n	$\bar{x}$ +-/n
NV + V_c n = 202	37 %	25 %	14 %	24 %
V n = 189	28 %	29 %	16 %	27 %
NV + V_s n = 161	20 %	34 %	13 %	33 %
PVL n = 209	18 %	40 %	17 %	25 %

temperature had an effect on thermoplastic plastic sheets (items 9, 10, and 11 related to task 4), (b) how air or vacuum could be used to exert a force (items 17, 18, and 19 related to task 7), and (c) how the presence or lack of heat and the use of force to stretch or hold a material against a mold interrelated with each other, (items number 30, 31, 32, and 33 related to tasks 12 and 13). Students assigned to the verbal treatment had difficulty with items concerned with (a) the definition of a sheet (items 3, 4, and 5 related to task 2), (b) the effect heat has on thermoplastic plastic sheets (items 7 and 8 related to task 3), and (c) the use of air and vacuum to exert a force (items 18 and 19 related to task 7).

The analyses of the data provided evidence for rejecting the null hypothesis and accepting the alternative hypothesis. The research hypothesis was that on the learning achievement test, the NV + V_s, V , and NV + V_c instructional media treatments would each achieve at a higher level than the one preceding. The NV + V_c and V treatment means were significantly different from the NV + V_s treatment mean. The NV + V_c and V means were not significantly different from each other. Each NV + V_s, V, and NV + V_c mean was larger than the preceding one (NV + V_s = 16.0, V = 18.1, NV + V_c = 19.6). Further analysis identified (a) that the order of the percentage of adjacent subordinate tasks passed by each treatment was in the same order as the treatment means, (b) that the percentage of adjacent tasks failed by each treatment was in the inverse order of the treatment means, and (c) students assigned to the NV + V_s treatment experienced difficulty in answering items associated with the upper subordinate tasks.

Hypothesis Number Three

The personal data collected were used to test the third hypothesis. The hypothesis was that treatment would not be a significant factor in predicting student performances on the learning achievement, final task, and transfer tests when combined with IQ, standardized achievement test scores, grades, and socio-economic status. Step-wise multiple regression was used to identify variables that accounted for a significant percentage of the variability. Values assigned to each treatment group were: NV + V_c = 4, V = 3, NV + V_s = 2, and PVL = 1. A 5, 4, 3, 2, or 1 was assigned to specify different socio-economic status levels.

The personal data collected for seventh grade students were different from the data collected for eighth grade students. Thus, different prediction equations were formulated for each grade level. Seventh grade students were administered the Educational Development Series (EDS) standardized test battery. The eighth grade students had been administered the Stanford Achievement Test battery (SAT). Variables included in the multiple regression analysis at the seventh grade level were socio-economic level; Otis Lennon IQ score; EDS IQ score, non-verbal, verbal, reading, English, mathematics, science, U.S.A, and solving problems sub-test scores; and treatment score.

Eighth grade variables were socio-economic level; English, history, mathematics, and science grades; Otis Lennon IQ score; SAT word meaning spelling, language, arithmetic comprehension, arithmetic concepts, arithmetic application, social studies, and science sub-test scores; and treatment score. Composite standardized achievement test scores were not included.

Means and variances were calculated for each variable to describe the population sampled. For the EDS sub-tests, the raw scores were changed to grade equivalent scores. The mean EDS and Otis Lennon seventh grade IQ scores were 97 and 97.5, respectively. The seventh grade EDS sub-test scores ranged from 6.0 through 6.7 ($\bar{x}$ = 6.2). The test was normed at the 6.5 grade level. The mean Otis Lennon eighth grade IQ score was 101. The range of the SAT sub-tests was 5.7 through 7.1 ($\bar{x}$ = 6.3). Arithmetic application and social studies sub-tests were the lowest (5.9 and 5.7, respectively). The highest was word meaning. The SAT test was normed at the 6.6 grade level.

The use of step-wise multiple regression to predict seventh and eighth grade performances on the final task and transfer test identified treatment as a significant variable. Treatment accounted for the largest amount of variability when multiple regression analysis was executed using the four treatment groups. The percentage of variability explained was small when the three instructional treatments were used. These results support the findings associated with hypothesis number one.

Variables identified as significant factors in predicting seventh and eighth grade student performances on the final task test were EDS reading score, SAT social studies score, history grade, SAT language score, SAT arithmetic computation score, SAT arithmetic concept score, and treatment. (See Tables 19 - 22.) A total of 4% of the variability was explained by the variable treatment when the three instructional groups were utilized. (See Tables 19 and 21.) Fourteen percent of the variability was explained when four treatment groups were used. (See Tables 20 and 22.)

Significant factors for predicting seventh and eighth grade student performances on the transfer test were EDS reading score, EDS IQ score, SAT arithmetic application score, SAT language score, SAT science score, science grade, and treatment. (See Tables 23 - 26.) When the four instructional treatments were used, the treatment was the first variable identified. It accounted for a total of 17% of the variability. (See Tables 24 and 26.) For the three instructional groups, treatment explained 3% of the variability. (See Tables 23 and 25.)

Treatment was identified as a significant variable for predicting seventh and eighth grade student performances on the learning achievement test. Significant variables identified were EDS reading score, Otis Lennon IQ score, SAT arithmetic application score, and treatment. (See Tables 27 and 28.) The variable treatment, explained a total of 18% of the variability when the multiple regression analysis

Table 19. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict Seventh Grade Student Performance on the Final Task Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .13 X_1 - .19$	19%**	---
$\hat{Y} = .12 X_1 + .96 X_2 - 3.18$		
Variables	X_1 = EDS Reading Score X_2 = Treatment	

** Significant at the .001 level

* Significant at the .05 level

Table 20. Summary of Multiple Regression Analysis on Four Treatments Used to Predict Seventh Grade Student Performances on the Final Task Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .11 X_1 + .05$	15%**	---
$\hat{Y} = .10 X_1 + 1.06 X_2 - 2.7$	26%**	11%
Variables	X_1 = EDS Reading Score	
	X_2 = Treatment	

** Significant at the .001 level

Table 21. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict Eighth Grade Student Performance on the Final Task Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .58 X_1 - .25$	11%**	---
$\hat{Y} = .77 X_1 - .61 X_2 + .49$	14%*	3%
Variables	X_1 = SAT Social Studies Score	
	X_2 = History Grade	

** Significant at the .001 level
 * Significant at the .01 level

Table 22. Summary of Multiple Regression Analysis on Four Treatments Used to Predict Eighth Grade Student Performance on the Final Task Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .22\ X_1 + 1.38$	8%**	---
$\hat{Y} = .22\ X_1 + .41\ X_2 + .43$	11%*	3%
$\hat{Y} = .48\ X_2 + .46\ X_3 - .13\ X_4 - .54$	13%*	2%

Variables

X_1 = SAT Language Score
X_2 = Treatment
X_3 = SAT Arithmetic Concept Score
X_4 = SAT Arithmetic Computation Score

** Significant at the .001 level

* Significant at the .05 level

Table 23. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict Seventh Grade Student Performance on the Transfer Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .09\ X_1 + 4.5$	10%*	---

Variable

X_1 = EDS Reading Score

* Significant at the .05 level

Table 24. Summary of Multiple Regression Analysis on Four Treatments Used to Predict Seventh Grade Student Performance on the Transfer Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .90\ X_1 + 4.3$	8%*	---
$\hat{Y} = .89\ X_1 + .05\ X_2 - .90$	14%*	6%

Variables

X_1 = Treatment

X_2 = EDS IQ Score

* Significant at the .05 level

Table 25. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict Eighth Grade Student Performance on the Transfer Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .68\ X_1 + 4.2$	13%**	---
$\hat{Y} = 1.22\ X_2 - .05\ X_3 + 4.6$	19%**	6%
$\hat{Y} = 1.09\ X_2 - .05\ X_3 + .91\ X_4 + 2.7$	25%*	6%
$\hat{Y} = 1.19\ X_2 - .06\ X_3 + .91\ X_4 + .90\ X_5 - .29$	28%*	3%

Variables

X_1 = SAT Arithmetic Application Score

X_2 = SAT Language Score

X_3 = SAT Science Score

X_4 = Science Grade

X_5 = Treatment

** Significant at the .001 level

* Significant at the .05 level

Table 26. Summary of Multiple Regression Analysis on Four Treatments Used to Predict Eighth Grade Student Performance on the Final Transfer Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = 1.0\ X_1 + 5.0$	9%**	---
$\hat{Y} = 1.2\ X_1 + .47\ X_2 + 1.5$	16%*	7%
$\hat{Y} = 1.3\ X_1 + .58\ X_2 + .008\ X_3 + 1.1$	19%*	3%

Variables

X_1 = Treatment

X_2 = SAT Arithmetic Application Score

X_3 = SAT Science Score

** Significant at the .001 level

* Significant at the .05 level

Table 27. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict Seventh Grade Student Performance on the Learning Achievement Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .28\ X_1 + 9.1$	37%**	---
$\hat{Y} = .28\ X_1 + 2.3\ X_2 + 1.9$	46%**	9%
$\hat{Y} = .19\ X_1 + 2.2\ X_2 + .12\ X_3 - 6.7$	51%*	5%

Variables

X_1 = EDS Reading Score

X_2 = Treatment

X_3 = Otis Lennon IQ Score

** Significant at the .001 level

* Significant at the .05 level

Table 28. Summary of Multiple Regression Analysis on Instructional Treatments Used to Predict Eighth Grade Student Performance on the Learning Achievement Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = .99 X_1 + 12.2$	16%**	---
$\hat{Y} = 1.04 X_1 + 1.98 X_2 + 5.8$	25%**	9%

Variables
X_1 = SAT Arithmetic Application Score
X_2 = Treatment

** Significant at the .001 level

was executed using the three instructional groups. This was considered to be more significant than treatment accounting for a total of 18% of the variability when four treatment groups were utilized. At the seventh grade level, reading accounted for 37% of the variability.

The results of the step-wise multiple regression were used to reject the null hypothesis. The research hypothesis accepted was that treatment would be a significant factor in the prediction of learning capability scores when combined with IQ, standardized achievement test scores, grades in previous courses, and socio-economic status. The results supported the findings associated with null hypothesis number one and research hypothesis number two.

The analyses of the junior high data identified that the NV + V_c and the V treatments had a significant effect on learning achievement test scores when compared with the NV + V_s treatment. There was no significant difference between the V and NV + V_c treatment (NV + V_c = 19.6, V = 18.1, NV + V_s = 16.0). The instructional treatments did not have a significant effect on the final task and transfer test scores. Instruction did have a significant effect on scores when compared with no-instruction.

Testing hypothesis number three identified treatment as a significant variable for predicting student performances on the learning achievement test when multiple regression was executed using the three instructional groups. Also, treatment was identified as a significant variable for predicting student performances on the final task and transfer tests. For the latter, treatment accounted for the largest amount of variability when four treatment groups were used to conduct the multiple regression analyses.

Analyses of Senior High Data

The tenth, eleventh, and twelfth grade students were randomly assigned to one of the four treatment groups. The total number of students per treatment group were: NV + V_c = 96, V = 60, NV + V_s = 106, and PVL = 66. Personal data were collected from 50% of the students. These data were utilized to test hypothesis number three.

Hypothesis Number One

The null hypothesis tested was that the amount of abstract understanding of a pre-selected technical concept taught by the use of the NV + V_c instructional media will be equal to the mean level of abstract understanding of students who have been taught by the

V instructional medium and the NV + V_s instructional media. The one-way analysis of variance and Duncan's multiple range tests were used to test this hypothesis.

The amount of abstract understanding was determined by student performances on the final task and transfer tests. (See Appendices P & Q, pp. 377-393 and 394-400.) A comparison of the NV + V_c, V , and NV + V_s treatment means was used to determine significant differences. A reverse in the expected linear order of the NV + V_s and PVL treatment means on the transfer test resulted in using all four treatments to determine significant differences. The unit of analysis was student performance, not class performance as used in the junior high data.

Treatment means and variances were used to assess student performances on the final task test. The means for the NV + V_c, V , NV + V_s and PVL treatments were 8.6, 6.2, 4.1, and 3.7, respectively. Calculated standard deviations were: NV + V_c = 3.3, V = 4.4, NV + V_s = 1.9, and PVL = 2.4 . The range for the NV + V_c, V , and PVL treatment was 0 through 11. The range for the NV + V_s treatment was 0 through 7 .

A one-way analysis of variance was conducted using the instructional treatment groups. (See Table 29.) Treatment was found to have a significant effect on student performances on the final task test ($\alpha = .01$).

Duncan's multiple range test was used to identify significant differences between the three instructional treatment means. (See Table 30.) Each treatment mean was significantly different from the other at the .05 level.

Table 29. Analysis of Variance of Senior High Student Performance on the Final Task Test Involving the Three Instructional Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	2	1034.59	517.30	52.25**
Within	259	2564.28	9.90	

** Significant at the .01 level ($F_{.01;\ 2,\ 259} = 4.67$)

Table 30. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Three Senior High Treatment Means on the Final Task Test

Treatment	$NV + V_s$	V	$NV + V_c$
Mean	4.1	6.2	8.6*

* Any two means not underscored by the same straight line were significantly different (α = .05)

Table 31. Analysis of Variance of Senior High Student Performance on the Transfer Test Involving Four Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	3	4124.27	1374.76	67.69**
Within	324	6580.70	20.31	

** Significant at the .01 level ($F_{.01;\ 3,\ 324} = 3.84$)

Senior high student performances on the transfer test were summarized by computing treatment means and standard deviations. The mean for the NV + V_c treatment was 13.8 with a standard deviation of 5.7 and a range of 1 through 25. The range for the V treatment was 1 through 26. The mean and standard deviation were 8.98 and 5.1, respectively. Mean and standard deviation for the NV + V_s treatment were 5.2 and 3.0. The scores ranged from 1 through 15. The mean for the PVL treatment was 6.5. The standard deviation was 4.0. The scores ranged from 0 through 18.

Since the PVL treatment mean was larger than the NV + V_s mean, the analysis of variance was conducted utilizing all four treatment groups (NV + V_s = 5.2, PVL = 6.5). (See Table 31.) The variance among treatments was significantly different from the variance within treatments (α = .01).

Significant differences among treatment means were determined. (See Table 32.) The NV + V_c treatment mean was significantly different from the V, PVL, and NV + V_s means. Also, the verbal mean was significantly different from the other means. The NV + V_s and PVL means were not significantly different.

The analyses of the senior high data supported the alternative hypothesis. The research hypothesis was that the amount of abstract understanding of a pre-selected technical concept taught by the use of the NV + V_c medium will be greater than the mean level of abstract understanding of students who have been taught by the use of the

Table 32. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Four Senior High Treatment Means on the Transfer Test

Treatment	NV + V_s	PVL	V	NV + V_c
Mean	5.2	6.5	8.98	13.8*

* Any two means not underscored by the same straight line were significantly different (α = .05)

Table 33. Analysis of Variance of Senior High Student Performance on the Learning Achievement Test Involving Four Treatment Groups

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Among	3	4374.19	1458.06	53.83**
Within	324	8775.59	27.09	

** Significant at the .01 level ($F_{.01,\ 3,\ 324}$ 0 3.84)

Table 34. Summary of Duncan's Multiple Range Test for Determining Significant Differences Among Four Senior High Treatment Means on the Learning Achievement Test

Treatment	NV + V_s	PVL	V	NV + V_c
Mean	17.6	18.7	21.7	26.4*

* Any two means not underscored by the same straight line were significantly different (α = .05)

V medium or the NV + V_s media. The NV + V_c and V treatment groups did significantly better on the final task and transfer tests than the NV + V_s treatment. In both cases, the NV + V_c treatment means were significantly greater than the V treatment means. The PVL treatment mean for the transfer test was larger than the NV + V_c mean (PVL = 6.4, NV + V_s = 5.2). There was no significant difference between the two means.

Hypothesis Number Two

The null hypothesis tested was that, on the learning achievement test, the mean performances of the NV + V_s , V , and NV + V_c instructional media treatments would be equal. The learning achievement test measured the amount of verbal knowledge the students had acquired. (See Appendix R, pp. 401 - 409.) Again, a reverse in the expected linear order of the NV + V_s and PVL treatment means resulted in conducting statistical tests on the data collected from the four treatment groups. The unit of analysis was student performance.

The means and variances for each treatment group were calculated. The means were NV + V_c = 26.4, V = 21.7, PVL = 18.7, and NV + V_s = 17.6. The standard deviations were 5.2, 6.1, 5.4, and 4.5, respectively. The scores ranged from 11 through 34 for the NV + V_c group. The range for the V treatment was 10 through 32, whereas, the range for the PVL treatment was 7 through 29. Scores for the NV + V_s treatment ranged from 5 through 26.

The analysis of variance was conducted utilizing data from all four treatment groups. (See Table 33.) Treatment was found to have a significant effect on student performances on the learning achievement test (α = .01).

Duncan's test identified the NV + V_c mean was significantly different from the V, NV + V_s, and PVL treatment means. (See Table 34.) The V mean was also found to be significantly different from the NV + V_c, NV + V_s, and PVL means. The PVL and NV + V_s means were not significantly different.

Differences among senior high student performances on the learning achievement test were further analyzed. The procedure used was (a) computing NV + V_c and V treatment positive transfer indexes, (b) determining the percentage of ++, --, -+, and +- patterns, (c) plotting item discrimination curves for each test item per treatment group, and (d) determining major differences between positive transfer indexes, among ++, --, -+, and +- patterns, and among item discrimination curves.

The performances of students assigned to the instructional groups were used to analyze the learning achievement test. (See Appendices R & W, pp. 401 - 409 and pp. 448 - 461.) The mean for the difficulty indexes was .64 . The range was .44 through .88 . The easiest items were related to the lower subordinate tasks. The discrimination indexes for all items were positive. The discrimination curve for question number 22 was somewhat erratic. Item-score correlations ranged from .23 through .53 ($\bar{x}$ = .42). Question 22 was not utilized in computing positive transfer indexes and KR_{20} value. The item-score correlations ranged from .32 through .53 ($\bar{x}$ = .42). The calculated value for KR_{20}, used to measure the homogeneity of the test, was .86 .

Differences between the NV + V_c and V treatments were determined by comparing positive transfer indexes. (See Appendix W, p. 461.) (See Tables 35 and 36.) The mean for the NV + V_c positive transfer indexes was .91 with a range from .75 through .99 . The mean for the V treatment was .84 . The range was .71 through .97 . Fifty-eight percent of the differences between the NV + V_c and V means was associated with Branch B of the hierarchy.

The percentage of ++, --, -+, and +- patterns among the four treatment groups were compared. (See Table 37.) The average ++, --, -+, and +- patterns for each treatment group was divided by the number of students per treatment. The order of the percentage of ++ patterns for each treatment was the same as the order of the treatment means. The percent of -- patterns per treatment was in the reverse order of the treatment means.

Differences between the NV + V_c, V , NV + V_s, and PVL treatments were determined by analyzing the item discrimination curves. Most of the NV + V_c students consistently passed the first 21 questions. Fifty to 75% of the students passed the remaining questions. These questions were concerned with tasks 9 through 13. (See Appendices R & W, pp. 401 - 409 and p. 461.) A majority of the students assigned to the V treatment passed the first 16 items. The remaining

Table 35. Positive Transfer Indexes Computed Between Adjacent Subordinate Tasks for Senior High Students Assigned to the NV + V_c Treatment

	Adjacent Tasks Examined	Test Items per Task Examined	(1) ++	(2) --	(3) -+	Positive Transfer Index*
A	1: 3	1,2: 6, 7, 8	75	2	18	.81
	2: 3	3,4,5: 6, 7, 8	90	1	3	.97
	3: 4	6,7,8: 9,10,11	79	2	1	.99
	3: 5	6,7,8:12,13	67	2	1	.99
	4:12	9,10,11:30,31	44	11	5	.92
	5:13	12,13:32,33	16	17	11	.75
B	6: 7	14,15,16:17,18,19	78	3	9	.90
	7:10	17,18,19:26,27	71	4	5	.94
	8: 9	20,21:23,24,25	66	7	2	.97
	9:10	23,24,25:26,27	69	4	1	.99
	9:11	23,24,25:28,29	36	20	6	.90
	10:12	26,27:30,31	39	16	10	.85
	7:11	23,24,25:28,29	40	11	9	.85
	11: 3	28,29:32,33	68	16	12	.88

* (1 + 2) / (1 + 2 + 3)

Table 36. Positive Transfer Indexes Computed Between Adjacent Subordinate Tasks for Senior High Students Assigned to the V Treatment

	Adjacent Tasks Examined	Test Items per Task Examined	(1) ++	(2) --	(3) -+	Positive Transfer Index*
A	1: 3	1,2: 6, 7, 8	33	3	13	.74
	2: 3	3,4,5: 6, 7, 8	39	4	7	.86
	3: 4	6,7,8: 9,10,11	31	6	8	.82
	3. 5	6,7,8:12,13	28	9	5	.88
	4:12	9,10,11:30,31	18	18	3	.92
	5:13	12,13:32,33	18	14	13	.71
B	6: 7	14,15,16:17,18,19	32	5	10	.79
	7:10	17,18,19:26,27	26	11	7	.84
	8: 9	20,21:23,24,25	28	9	9	.80
	9:10	23,24,25:26,27	31	3	1	.97
	9:11	23,24,25:28,29	14	22	6	.86
	10:12	26,27:30,31	15	22	6	.86
	7:11	23,24,25:28,29	15	21	6	.86
	11:13	28,29:32,33	37	10	13	.78

* (1 + 2) / (1 + 2 + 3)

Table 37. Comparison of the Percentage of ++, --, -+, and +- Patterns per Treatment Group of Senior High Student Performance on the Learning Achievement Test

Treatment	$\overline{x}$ ++/n	$\overline{x}$ --/n	$\overline{x}$ -+/n	$\overline{x}$ +-/n
NV + V_c n = 96	63 %	8 %	7 %	22 %
V n = 60	43 %	18 %	13 %	26 %
NV + V_s n = 106	28 %	30 %	12 %	30 %
PVL n = 66	31 %	29 %	12 %	28 %

questions, related to tasks 7 through 13, were passed by 40 to 75% of the students. Twenty to 60% of the students in the NV + V_S treatment passed questions 23 through 34. These questions were related to tasks 9 through 13. Most of the PVL treatment students passed the questions related to the lower subordinate tasks and failed the items related to subordinate tasks 12 and 13.

The comparison of item discrimination curves per treatment identified students assigned to the V treatment had difficulty in answering questions concerned with the effect which too much heat had on thermoplastic plastic sheets and the definition of force (questions 10 and 14). Students assigned to the NV + V_S treatment had difficulty in answering questions 9 and 23. Question number 9 was concerned with specifying the characteristics of a thermoplastic sheet that has reached its shaping temperature. The definition of shape was the topic of question number 23.

An interesting relationship was detected between questions number 18 through 21, and 25. The discrimination curves for the NV + V_C and NV + V_S treatments were similar. The curves for the V and PVL treatments were also similar, but different from the NV + V_C and NV + V_S curves. Questions 18 through 21 were concerned with the use of air or vacuum to exert a force and the definition of a mold. Question 25 was concerned with the application of the students' understanding of shape to solve a problem. The researcher assumed that the presence or lack of use of the non-verbal instructional media caused the differences in student responses.

After analyzing the data related to the second hypothesis, the alternative hypothesis was accepted. The research hypothesis was that on the learning achievement test, the NV + V_s, V , and NV + V_c instructional media treatment groups would each achieve at a higher level than the one preceding. The NV + V_c, V , NV + V_s means were significantly different from each other. The PVL mean was larger, but not significantly different from the NV + V_s mean. (NV + V_c = 26.4, V = 21.7, PVL = 18.7, and NV + V_s = 17.6 .) Further analysis indicated (a) that the order of the percentage of adjacent tasks passed by each treatment was in the same order as the treatment means, (b) that the percentage of the adjacent tasks failed per treatment was in the inverse order of the treatment means, (c) that the majority of the differences among treatment means was associated with student performances on questions related to tasks 9 through 13, and (d) that the presence or lack of the use of the nonverbal instructional medium had an effect on students' answers to questions related to the use of air or vacuum to exert a force, the definition of a mold, and the definition of shape.

Hypothesis Number Three

The testing of hypothesis number three involved analyzing data collected from 50% of the senior high students assigned to the instructional treatment groups. The null hypothesis was that treatment would not be a significant factor in predicting student performances on the learning achievement, final task, and transfer tests when combined with IQ, standardized achievement test scores, grades, and socio-economic status. In order to identify variables that accounted for a significant percentage of the variability related to student performances, the data collected from the three instructional treatments were used in a step-wise multiple regression analysis.

The data collected consisted of junior high English, history, mathematics, and science grades; Otis Lennon and EDS IQ scores; scores on the SAT word meaning, paragraph meaning, spelling, language, arithmetic comprehension, arithmetic concepts, arithmetic application, social studies, and science sub-tests, and scores on the EDS non-verbal, verbal, reading, English, mathematics, science, U.S.A., and problem solving sub-tests. A socio-economic status of 1, 2, 3, 4, or 5 was assigned to each student. Scores for treatment groups were assigned: $NV + V_c = 4$, $V = 3$, and $NV + V_s = 2$.

The population sampled was described by calculating means and variances for each variable. The standardized achievement test scores were changed to grade-equivalent scores. The mean EDS IQ score was 104, whereas, the mean Otis Lennon IQ score was 108. The SAT sub-test scores ranged from 6.1 through 7.5 ($\bar{x} = 6.7$). The two seventh grade scores were on the science and arithmetic application sub-tests, the latter being the highest. Arithmetic comprehension was the lowest. The test was normed at the 6.5 grade level. The EDS test was administered during the ninth, tenth, and eleventh grades. The mean was 11.0, with a range from 10.7 through 11.7. The highest sub-test mean was the U.S.A. The mean grade-level score for the non-verbal, verbal, and English sub-tests was 10.7 .

Treatment, Otis Lennon IQ score, and SAT language score were identified as significant variables for predicting senior high student performances on the final task test. (See Table 38.) Treatment was the first variable identified. It accounted for 28% of the variability.

Significant variables found for predicting senior high student performances on the transfer test were treatment, SAT paragraph meaning score, and junior high mathematics grades. (See Table 39.) Treatment, the first variable signified, explained 44% of the variability.

On the learning achievement test, treatment also was the first variable specified. (See Table 40.) Twenty-seven percent of the variability was explained by the variable. Other significant variables were Otis Lennon IQ score and junior high mathematics grades.

Treatment was identified as a significant variable for predicting senior high student performances on the final task, transfer, and final task tests. For each test, treatment was the first variable identified and accounted for the largest amount of variability. Thus, the alternative hypothesis was accepted. The hypothesis was that treatment would be a significant factor in the prediction of learning capability scores when combined with IQ, standardized achievement test scores, grades in previous courses, and socio-economic status. The identification of treatment as a significant variable for predicting test scores supported hypotheses one and two.

Table 38. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict High School Student Performance on the Final Task Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = 1.96 X_1 + .96$	28%**	---
$\hat{Y} = 1.8 X_1 + .095 X_2 - 8.7$	40%*	12%
$\hat{Y} = 1.6 X_1 + .06 X_2 + .29 X_3 - 6.6$	44%*	4%

Variables

X_1 = Treatment
X_2 = Otis Lennon IQ Score
X_3 = SAT Language Score

** Significant at the .001 level
* Significant at the .05 level

Table 39. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict High School Student Performance on the Transfer Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = 4.6 X_1 - 3.8$	44%**	---
$\hat{Y} = 4.0 X_1 + .8 X_2 - 7.7$	54%*	10%
$\hat{Y} = 3.96 X_1 + .57 X_2 + 1.3 X_3 - 10.5$	56%*	2%

Variables

X_1 = Treatment
X_2 = SAT Paragraph Meaning Score
X_3 = Junior High Mathematics Grade

** Significant at the .001 level
* Significant at the .05 level

Table 40. Summary of Multiple Regression Analysis on Three Instructional Treatments Used to Predict High School Student Performance on the Learning Achievement Test

Prediction Equation	% of Variability Explained	% of Variability Explained by Additional Variable
$\hat{Y} = 3.8 X_1 + 10.9$	27%**	---
$\hat{Y} = 3.3 X_1 + .21 X_2 - 10.4$	44%**	17%
$\hat{Y} = 3.1 X_1 + .16 X_2 + 1.34 X_3 - 9.6$	47%*	3%
Variables	X_1 = Treatment X_2 = Otis Lennon IQ Score X_3 = Junior High Mathematics Grade	

** Significant at the .001 level

* Significant at the .05 level

The analyses of the senior high data indicated that the NV + V_c and the V treatments each had a significant effect on learning achievement test scores when compared with the PVL and NV + V_s treatments. The PVL treatment mean was not significantly different from the NV + V_s mean (NV + V_c = 26.4, V = 21.7, PVL = 18.7, NV + V_s = 17.6). The amount of abstract learning was determined by student performances on the final task and transfer tests. The NV + V_c, V, and NV + V_s treatment means were found to be significantly different from each other (NV + V_c = 8.6, V = 6.2, NV + V_s = 4.1). On the transfer test, the NV + V_c and V treatment means were also significantly different from each other and the NV + V_s and PVL treatment means. No significant difference was determined between the PVL and NV + V_s means (NV + V_c = 13.8, V = 8.98, PVL = 6.5, NV + V_s = 5.2).

Treatment was identified as a significant variable for predicting student performances on the learning achievement, final task, and transfer tests. This finding supported research hypotheses one and two.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was conducted to determine the effect nonverbal and verbal instructional guidelines had on junior and senior high school students' abstract understanding of technical concepts. The three instructional guidelines tested were based upon approaches suggested by Gagné. These approaches were concerned with the importance of laboratory activities and demonstrations in science.

The three instructional approaches involved (a) the use of environmental stimuli to complement the verbal medium, (b) the use of the verbal medium alone, and (c) the use of the verbal medium to provide directions for completing specific environmental tasks (learning by doing). In dealing with these approaches, Gagné predicted that the use of the verbal medium alone and the "learning by doing" approach would result in oververbalization and superficial verbal learning.

Based upon these three instructional approaches, three questions were formulated: Did the instructional procedure using the verbal medium supplementing the nonverbal medium (learning by doing) provide students with enough information that they were able to develop an abstract understanding of technical concepts? Did the use of the verbal medium alone result in students recalling past experiences needed to acquire meaningful and accurate understanding of technical concepts to solve contextually-related problems? Did the use of the nonverbal medium complementing the verbal medium result in students developing abstract understanding of technical concepts?

Statement of the Problem

The problem was to determine if the verbal instructional medium complementing the nonverbal instructional medium would result in students developing a higher level of abstract understanding of a pre-selected technical concept than the use of the verbal instructional medium alone or the verbal instructional medium supplementing the nonverbal medium.

Need for the Study

This study was based upon the need for students to develop a higher level of abstract understanding of industrial arts subject matter. This premise was based upon a review of literature related to major industrial arts curriculum plans developed during the last fifteen years.

Purpose of the Study

The identification of instructional guidelines could help industrial arts teachers become aware of the need to (a) discriminate differences between the subject matter of industrial arts and instructional procedures, and (b) interrelate unique characteristics of both in order to develop a teaching strategy which emphasizes abstract learning.

When the verbal instructional medium is used to describe how the nonverbal activity should be completed (learning by doing), the procedure for completing the process becomes the "content" and "method" of instruction. Based upon the hierarchy of learning conditions, Gagné predicted this approach would result in students not developing an abstract understanding of the process being taught.

The researcher assumed that the separation of content and method would enable students to develop an abstract understanding of a technical principle. The teacher would have to identify and define what the students are to understand. Then the teacher would have to provide instruction, based upon some guidelines, that would result in the students acquiring an abstract understanding of what is being taught. The results of this study could help the teacher become aware of the need for changing his teaching strategy and provide guidelines for making this change.

Summary of Procedures

Gagné's hierarchy of learning conditions and subordinate hierarchy were used to operationally define the three instructional procedures. The hierarchy of learning conditions (the ordering of different types of learning, whereby the next highest level is dependent upon the adjacent lower-level) was used to define (a) the verbal medium complementing the nonverbal medium (NV + V_c), (b) the verbal medium alone (V), and (c) the verbal medium supplementing the nonverbal medium (NV + V_s). The subordinate hierarchy (a hierarchy of intellectual operations determined necessary for a large number of students to acquire the understanding of a concept) was used to structure the NV + V_c and V lessons.

The strategy used for planning the NV + V_c and V lessons involved (a) determining the abstract learning expected of the students, (b) identifying and ordering in a subsuming manner the intellectual operations the students were expected to acquire, and (c) identifying instructional procedures that interrelated each lower-level intellectual task with the next highest adjacent subordinate task. The planning moved from the abstract to the concrete, whereas, instruction progressed from the concrete to the abstract. The NV + V_c instructional procedures utilized environmental stimuli (nonverbal medium) to operationally define the attributes of a technical concept. The V procedure used only the verbal medium.

The steps used to plan the NV + V_c and V lessons consisted of (a) identifying a technical principle, (b) defining the attributes of the principle, (c) stating the nature of the abstract learning expected of the student related to the principle selected, (d) specifying the final subordinate task, (e) asking the question: "What would the individual already have to know how to do in order to learn this new capability simply by being given verbal instructions?" of the final task and each subordinate task identified, (f) defining behavioral objectives for each superordinate level and subordinate task, (g) designating verbal and nonverbal instructional procedures per subordinate task, and (h) developing instructional materials.

Care was taken to make sure that the instructional procedures related to each task subsumed the lower adjacent task or tasks.

The NV + V_s lesson emphasized the "learning by doing" approach. The nonverbal medium was utilized to present new content, procedures for constructing a product. The verbal medium was utilized to describe and/or name new actions, objects or events.

Research related to the development of the subordinate hierarchy was used to operationally define abstract learning. Gagné identified that abstract learning was measured by the learner's ability to (a) interrelate the attributes of a principle into a meaningful whole to complete a final subordinate task (final task test) and (b) apply the newly-acquired cognitive capability and strategy to novel, contextually-related problem solving situations (transfer test).

The effectiveness of the subordinate hierarchy and tests were determined by conducting three pilot studies. The procedure used for conducting each pilot study involved (a) planning and developing the instructional procedures to be administered, (b) constructing test materials, (c) administering the treatments, (d) collecting data, (e) evaluating the lesson or lessons, (f) evaluating the tests administered, (g) computing positive transfer indexes, and (h) refining the subordinate hierarchy. Changes that were made in the hierarchy were used to restructure the instructional procedures and test materials for the next pilot study.

The test materials consisted of three tests. The final task test, administered first, and the transfer test, administered second, were used to measure abstract learning. The third test, the achievement test, was utilized to determine the amount of verbal knowledge acquired. The evaluation of the tests was based upon the performances of students assigned to each instructional treatment group and the no-instructional treatment group (PVL). The latter was used to determine the amount of previous verbal learning the students had acquired about the principle of thermoforming. The learning achievement test was evaluated by calculating item difficulty indexes, computing item discrimination indexes, and plotting discrimination curves. Based upon Gagné's previous research, positive transfer indexes were calculated to determine the students' patterns of capability to complete adjacent subordinate tasks. These patterns were used to evaluate the effectiveness of the subordinate hierarchy.

The reliability of the tests was determined from the results of a fourth pilot study. This was completed after the subordinate hierarchy and instructional procedures were refined, evaluated, and video taped. The fourth pilot study also served as a means for re-evaluating the tests and evaluating the instructional procedures used to provide directions for the teachers to administer each treatment.

The collection of the data involved administering the PVL, NV + V_s, V , and NV + V_c treatments to 1089 junior and senior high school students. The collection of the junior high data involved randomly assigning junior high schools from a county school system to different treatment groups and randomly selecting seventh and eighth grade industrial arts classes from each treatment group. The collection of the senior high data consisted of identifying four senior high schools with biology and mechanical drawing teachers who were willing to participate in the study. The collection of data at both levels included administering the treatments and collecting personal data from 50% of the students in each treatment group. The study was conducted at the senior high school level because the researcher assumed that senior high school students had developed mental and language capabilities which would enable them to acquire an abstract understanding of thermoforming.

Hypotheses

The following research hypotheses were tested:

1. The students' amount of abstract understanding of a pre-selected technical concept taught by the use of the verbal instructional medium complementing the nonverbal instructional medium (NV + V_c) will be greater than the mean level of abstract understanding of students who have been taught by the use of the verbal instructional medium (V) or the verbal instructional medium supplementing the nonverbal instructional medium (NV + V_s).
2. On the learning achievement test, it was predicted that the NV + V_s, V , and NV + V_c instructional media treatments would be achieved, each at a higher level than the one preceding.
3. The treatment would be a significant factor in the prediction of learning capability scores when combined with IQ, standardized achievement test scores, grades in previous courses, and socio-economic status.

A one-way analysis of variance and Duncan's multiple range test were used to test hypotheses one and two. A step-wise multiple regression analysis was utilized to test hypothesis number three.

Whenever possible, significant differences were determined among instructional treatment means instead of comparing no-instruction (PVL) with instruction.

Conclusions

The junior and senior high school data were analyzed, each separately, then compared with each other. The latter resulted in identifying variables which accounted for the differences between junior and senior high school student performances. Conclusions related to the above were used to derive major outcomes and insights related to the study.

Junior High School Level

No significant differences were determined among the instructional treatment means on the final task and transfer tests. The no-instructional (PVL) mean was significantly different from each instructional mean (Final task test means: $NV + V_c = 3.8$, $V = 3.5$, $NV + V_s = 3.1$, $PVL = 1.8$; Transfer test means: $NV + V_c = 8.0$, $V = 8.0$, $NV + V_s = 7.4$, and $PVL = 5.0$).

Significant differences were identified among the three instructional treatment means on the learning achievement test. The $NV + V_c$ treatment mean and V treatment mean were both significantly different from the $NV + V_s$ mean. No difference was determined between the $NV + V_c$ and V treatment means ($NV + V_c = 19.6$, $V = 18.1$, $NV + V_s = 16.0$).

Treatment was identified as a significant variable for predicting student performances on the final task and transfer tests when multiple regression analysis was used to analyze data from the three instructional and four treatment groups. Treatment accounted for the largest amount of variability when the analysis was conducted using the four treatment groups. This finding supported the results of the statistical analyses used to accept null hypothesis number one.

On the learning achievement test, treatment accounted for a total of 18% of the variability when data from the three instructional treatments were analyzed. The identification of treatment as a significant variable supported the findings associated with research hypothesis number two.

Significant variables identified for predicting learning achievement scores at the seventh grade level were Educational Development Series (EDS) reading score, treatment, and Otis Lennon IQ score. Reading was the first variable identified which accounted for 37% of the variability. Significant variables at the eighth grade level were Stanford Achievement (SAT) arithmetic application score and treatment.

Since many significant variables were identified for predicting seventh and eighth grade student performances on the three tests, a further analysis of the personal data collected was conducted. (See Tables 19 - 28, pp. 140 - 145.) The analysis involved computing correlation coefficients among variables associated with the personal data collected and performances on the final task, transfer, and learning achievement tests. (See Chapter III, pp. 115 - 116.)

For each grade level, a plus value was assigned to the four variables that had the highest correlation coefficient for each test. The variables with the lowest coefficients were assigned a minus value. Variables with plus and minus values for each test were identified as being the most or least important variables related to student performances on the three tests.

At the seventh grade level, socio-economic status level and EDS nonverbal score were identified as being the least important variables when the analysis was conducted using data from the three instructional and four treatment groups. EDS reading score was signified as the most important variable. The relationship of each variable to each test was plotted on a graph. The profile plotted for the learning achievement and final task tests were similar. These profiles were different from the profile plotted for the transfer test.

At the eighth grade level, socio-economic status level and SAT word meaning score were the least important variables identified when data from four treatment groups were analyzed. The most important variable was SAT social studies score. When the three instructional treatments were used, arithmetic application score was signified as the most important variable. No variable was identified as being least important. The profiles for each test were different.

In conclusion, the use of the subordinate hierarchy, accompanied by verbal (V) instruction, and the use of the subordinate hierarchy, accompanied by the nonverbal instruction medium complementing the verbal ($NV + V_c$) had a significant effect on the amount of verbal knowledge which seventh and eighth grade students acquired during one class period of instruction. The students, regardless of the instructional treatment administered, were unable to organize the attributes of a technical concept into a meaningful whole and use their cognitive understanding of the principle to solve contextually-related problems.

Reading ability, type of treatment, and IQ were identified as significant variables for predicting seventh grade student performances on the learning achievement test. These variables accounted for 51% of the variability. At the eighth grade level, arithmetic application and type of treatment explained 25% of the variability.

Reading was identified as the most important variable associated with seventh grade student performances on the three tests. The least important variables specified were socio-economic status level and nonverbal reasoning. At the eighth grade level, no one variable was consistently identified as the least or most important variable.

Senior High School Level

Significant differences were identified among each of the $NV + V_s$, V , and $NV + V_c$ treatment means on the final task, transfer, and learning achievement tests (Final task test: $NV + V_c = 8.6$, $V = 6.2$, $NV + V_s = 4.1$; Transfer test: $NV + V_c = 13.8$, $V = 8.98$, $NV + V_s = 5.2$; Learning achievement test: $NV + V_c = 26.4$, $V = 21.7$, $NV + V_s = 17.6$). A reverse in the expected linear order of the $NV + V_s$ and PVL treatment means occurred on the transfer and learning achievement tests. No significant differences were detected between the PVL and NV + V_s treatment means for each test (Transfer test: PVL = 6.5, NV + V_s = 5.2; Learning achievement test: PVL = 18.7, NV + V_s = 17.6).

Significant variables for predicting student performances on the final task test, in the order they were identified, were: treatment (28% of the variability), Otis Lennon IQ score (an additional 12% of the variability), and SAT language score (an additional 4% of the variability). For predicting student performances on the transfer test, treatment (44% of the variability), SAT paragraph meaning (an additional 10% of the variability), and junior high mathematics grade (an additional 2% of the variability) were identified as significant variables. On the learning achievement test, treatment (27% of the variability, Otis Lennon IQ score (an additional 17% of the variability), and junior high mathematics grade (an additional 3% of the variability) were identified as significant variables for predicting student performances. The identification of treatment as a significant variable for predicting student performances on the three tests supported the findings associated with research hypotheses one and two.

In conclusion, the use of the subordinate hierarchy, accompanied with verbal (V) instruction, had a significant effect on the amount of verbal knowledge and abstract understanding of technical concepts acquired during one class period when compared with the "learning by doing" (NV + V_s) approach. In turn, the use of the subordinate hierarchy, accompanied by the nonverbal instructional medium complementing the verbal (NV + V_c) had a significant effect on the amount of verbal knowledge and abstract understanding of a technical concept when compared with the V and NV + V_S instructional procedures. The PVL treatment mean being larger than, but not significantly different from, the NV + V_S mean was assumed to have resulted from (a) students having acquired some previous verbal knowledge about the attributes of thermoforming and (b) the "learning by doing" instructional procedure limiting the students' abilities to apply their previously acquired verbal knowledge and understanding to answer questions on the final task, transfer and learning achievement tests.

The type of treatment administered was identified as the most important single variable for predicting student performances on the three tests. Type of treatment, IQ, and language, which accounted for 44% of the variability, were identified as significant variables for predicting student performances on the final task test. For predicting student performances on the transfer test, type of treatment, paragraph meaning, and junior high mathematics grades were significant variables. They accounted for 56% of the variability. Significant variables for predicting the amount of verbal knowledge which the students acquired were type of treatment, IQ, and junior high mathematics grade. These variables explained 47% of the variability. The researcher was unable to explain why junior high mathematics grades were identified as a significant variable. It accounted for a total of 5% of the variability.

Comparison of Junior and Senior High School Results

A major limitation of this study was the presentation of the NV + V_C, V , and NV + V_S lessons within a 45-minute class period. Within this limitation, the amount of previous knowledge acquired and the mental and language maturation of senior high school students were identified as important variables which accounted for differences among junior and senior high school student performances on the final task, transfer, and learning achievement tests.

The premise that senior high school students had acquired previous knowledge about thermoforming was based upon an examination of differences between junior and senior high school PVL treatment menas. There was a difference of 3.8 between the PVL treatment means associated with the learning achievement test. This indicated that senior high school students had acquired previous verbal knowledge about the basic attributes of thermoforming, as compared with junior high school students (Senior high = 18.7, Junior high = 14.9). This finding was supported by differences among senior high and junior high PVL item discrimination curves. More senior high school students consistently passed more lower-level subordinate tasks than did junior high school students.

The researcher assumed that the additional verbal knowledge acquired by senior high school students enabled them to achieve higher scores on the final task and transfer task tests (Final task test: Senior high PVL mean = 3.7, Junior high PVL mean = 1.8; Transfer test: Senior high PVL mean = 6.5, Junior high PVL mean = 5.0).

The effect which mental and language maturation had upon differences among junior and senior high school student performances was based upon four findings. First, the amount of verbal knowledge senior high school students acquired was greater than that acquired by junior high school students (Senior high treatment means: NV + V_c = 26.4, V = 21.7, NV + V_s = 17.6; Junior high treatment means: NV + V_c = 19.6, V = 18.1, NV + V_s = 16.0). This would indicate that senior high school students were able to process more information in the same amount of time and acquire a better understanding of the attributes of thermoforming than junior high school students.

The latter was supported by the percentage of ++ and -- patterns of junior and senior high school students' responses on the learning achievement test. Senior high school students were able to consistently pass more test items related to adjacent subordinate tasks than junior high school students (Senior high ++ patterns: NV + V_c = 63%, V = 43%, PVL = 31%, NV + V_s = 28%; Junior high ++ patterns: NV + V_c = 37%, V = 28%, NV + V_s = 20%, PVL = 18%). At the same time, senior high school students failed less items related to adjacent subordinate tasks (Senior high -- patterns: NV + V_c = 8%, V = 18%, PVL = 29%, NV + V_s = 30%; Junior high -- patterns: NV + V_c = 25%, V = 29%, NV + V_s = 34%, PVL = 40%). Item discrimination curves for each treatment group at the junior and senior high school level indicated that senior high school students consistently passed more lower-level subordinate tasks than junior high school students. Also, senior high school students were able to pass more items related to higher subordinate tasks than junior high school students.

Second, senior high school students had acquired cognitive capabilities which enabled them to interrelate attributes into a meaningful whole and use their newly-acquired ability to solve contextually-related problems. The amount of abstract learning senior high school students assigned to the NV + V_c and V treatments acquired were each significantly different from the NV + V_s treatment. At the junior high school level, students were unable to acquire an abstract understanding of a principle, regardless of the type of instructional treatment administered.

Third, differences among procedures used to administer the treatment to junior and senior high school students further identified intellectual maturation as being an important variable. At the senior high school level, the programmed instruction booklet was not needed to provide instructions for students to take the final task test. Also, the Learning Tasks Sheet was completed by students assigned to the NV + V_c and V treatment groups while they watched the video taped lessons. Furthermore, the audio tape was not needed for administering the tests.

The researcher assumed that the change in procedure and the ability of students to acquire an abstract understanding of a principle resulted in predictors of junior high student performances on the final task and transfer tests not being identified at the senior high school level. Predictors at the junior high school level were junior high science grade, assigned treatment score, and SAT social studies, SAT language, SAT arithmetic concept, SAT arithmetic computation, SAT arithmetic application, SAT science, and EDS IQ scores. Significant variables identified at the senior high school level were assigned treatment score, junior high mathematics grade, and Otis Lennon IQ, SAT language, and SAT prargraph meaning scores.

Fourth, the identification of treatment as the most important single variable for predicting senior high school student performances on the tests further indicated intellectual maturation as an important variable. The type of treatment was the first variable identified for predicting senior high school student performances. It explained 67% of the variability. IQ score accounted for an additional 20% of the variability. An additional 7% of the variability was explained by SAT paragraph meaning scores. At the junior high school level, treatment accounted for a total of 18% of the variability when the NV + V_c and V treatment means were significantly different from the NV + V_s treatment on the learning achievement test.

Major Outcomes

The findings of this study indicated that (a) the use of instructional guidelines associated with the NV + V_c treatment resulted in students acquiring the highest level of abstract understanding of a technical principle and (b) the students' capabilities to acquire an abstract understanding of a technical principle were associated with their intellectual maturity. The NV + V_c instructional guidelines involved (a) identifying and defining a technical principle, (b) identifying and defining the major attributes of a technical principle, (c) specifying the abstract learning expected of students related to the principle selected, (d) identifying the subsuming order of, and the major interrelationships between, the attributes of the principle, (e) relating the lower-order attributes to concepts which students have already acquired, (f) specifying the intellectual operations which the students were expected to acquire associated with each subsuming task identified, (g) structuring the verbal medium to help students acquire and interrelate each subsuming task with adjacent tasks, (h) specifying environmental stimuli (nonverbal medium) to operationally define attributes related to each subsuming task, (i) informing students what was expected of them, and (j) providing a means for students to review and interrelate each subsuming task with adjacent tasks.

Insights

Two major insights of this study were that (a) a technical principle is very specific, and (b) the computation of positive transfer indexes was not a very effective system for determining student performances on adjacent subordinate tasks.

The fact that a technical principle was very specific resulted from developing the subordinate hierarchy, the transfer test, and the final task test. The development of the subordinate hierarchy illustrated the need to define what attributes interrelated with other attributes, how they interrelated, and which attributes subsumed other attributes. Alternating the attributes or the interrelationship of one attribute to another resulted in the technical principle no longer depicting the original artifact.

The resolution that the computation of positive transfer indexes was not an effective system for determining positive transfer was based on the procedures used to analyze student performances on the learning achievement test. Gagné developed and used positive transfer indexes in 1962. In this and later research, a priori learning conditions were established. These a priori conditions assure that the learner would develop proficiencies which resulted in him successfully completing the upper subordinate tasks. Two common approaches used were programmed instruction and individual instruction over a period of time, usually three to five class periods. This researcher assumed that the a priori learning condition was the bases for Gagné and associates identifying that a positive transfer index of 1.00 indicated that the student had passed all subordinate adjacent tasks.

A priori learning conditions were not utilized in conducting this study. Second, criteria were established to evaluate how each learning achievement test item was expected to function. Because of these two factors, the positive transfer indexes that were computed by the researcher were not expected to compare with those reported by Gagné and associates. Thus, an increase in the amount of -- patterns when the amount of ++ and -+ patterns were held constant, resulted in an increase in the positive transfer index without positive transfer occurring (Positive Transfer Index = (1 + 2)/(1 + 2 + 3), whereby 1 = the number of ++ patterns, 2 = the number of -- patterns, and 3 = the number of -+ patterns). Thus, the researcher used the percentage of ++, --, -+, and +- patterns per adjacent subordinate task to analyze the junior and senior high data. If further research were to be conducted similar to this study, other means for analyzing positive transfer should be investigated.

Recommendations

The results of this study have generated more questions than they have answered. These questions, related to specific topics, could provide the impetus for further research. Possible topics are:

1. The effect NV + V_c and V instructional guidelines have on the retention of a technical principle. Do the NV + V_c and V instructional guidelines have their greatest effect on learning or retention? Does the use of the NV + V_c and V instructional guidelines result in students retaining the upper subordinate tasks and forgetting the lower subordinate tasks?

2. The effect an advanced organizer has on the learning and retention of a technical principle. Does the use of an advanced organizer have its greatest effect on learning or retention? Does the organizer have more effect on learning or retention when the V or NV + V_c guidelines are utilized? How and where should the organizer be presented in the guidelines so that it will have the most effect on learning and retention?

3. The effect the interaction between intellectual maturation and time to learn has on the use of NV + V_c and V instructional guidelines for students to acquire an abstract understanding of a technical principle.
   What effect does each of the following variables have on each other when the NV + V_c and V guidelines are utilized: (a) instruction in intervals of 15 - 20 minutes over a period of three or four days, (b) the use of laboratory activities, (c) a lapse of time between learning and testing, (d) review sessions within the lapsed time between learning and testing, and (e) different intellectual maturation levels of students? What type of laboratory activity provides the most efficient means for helping students acquire or retain an abstract understanding of a principle? Are there readily identifiable variables that can be used to specify the sequencing of the instructional approaches, depending upon the intellectual maturation of the student?

4. The effect V and NV + V_c instructional guidelines have on different learning strategies utilized by students to develop an abstract understanding of a technical concept?
   Do students move from the concrete to the abstract, abstract to the concrete, or both, when engaging in abstract learning? Are there readily identifiable variables that can be used to identify these different learning strategies? Does the use of the V or NV + V_c guidelines have a different effect on different learning strategies utilized by students? Is the V instructional medium equally as effective for verbal, verbal and nonverbal, and nonverbal oriented students as the NV + V_c instructional procedure?

BIBLIOGRAPHY

BIBLIOGRAPHY

American Association for the Advancement of Science. The Psychological Bases of Science--A Process Approach. Washington, D.C.: Author. 1965. 35 pp.

American Association for the Advancement of Science. Science--A Process Approach: An Evaluation Model and Its Application. Washington, D.C.: Author. 1968. 238 pp.

Amidon, Edmund J., and Flanders, Ned A. The Role of the Teacher in the Classroom: A Manual for Understanding and Improving Teachers' Classroom Behavior. Philadelphia, Pennsylvania: Temple University. 1962. 67 pp.

Amidon, Edmund, and Hough, John B. (Eds.) Interaction Analysis: Theory, Research and Application. Reading, Massachusetts: Addison-Wesley. 1967. 402 pp.

Anderson, Charles. "A Theory of Nonverbal Creativity." Paper presented at the Canadian Council for Research in Education, Ottawa, Canada. June, 1968. 16 pp. (ERIC Microfiche No. ED-025-814).

Anderson, Richard C., and Ausubel, David P. (Eds.) "Preface." In Readings in the Psychology of Cognition. New York, New York: Holt, Rinehart, and Winston, Inc. 1965. pp. v - vii.

Ausubel, David P. "Introduction." In Anderson, Richard C., and Ausubel, David P. (Eds.), Readings in the Psychology of Cognition. New York, New York: Holt, Rinehart, and Winston, Inc. 1965. pp. 3 - 17.

Ausubel, David P. "Cognitive Structure and the Facilitation of Meaningful Verbal Learning." Journal of Teacher Education 1963. 14: 217-221.

Ausubel, David P. Educational Psychology: A Cognitive View. New York, New York: Holt, Rinehart, and Winston, Inc. 1968. 685 pp.

Baird, Ronald J. Industrial Plastics. South Holland, Illinois: Goodheart-Willcox, Inc. 1971. pp. 155-174.

Barnlund, Dean C. Interpersonal Communication Survey and Studies. Boston, Massachusetts: Houghton Mifflin Company. 1968. 727 pp.

Birdwhistell, Raymond L. "Kinesics and Communication." In Carpenter, Edmund S., and McLuhan, Marshall (Eds.), Explorations in Communication. Boston, Massachusetts: Beacon Hill. 1960. pp. 54-64.

Blazer, Able LeVon. "An Exploratory Investigation of Verbal and Non-Verbal Behavior of B.S.C.S. Teachers and Non-B.S.C.S. Teachers." Unpublished doctoral dissertation, Ohio State University, Ohio. 1968. 242 pp.

Bock, Philip K. "Technological Systems." In Modern Cultural Anthropology. New York, New York: Knopf. 1969. pp. 221-309.

Coleman, Lois T. "A Study of the Acquisition of the Intellectual Skill Comparing in the Area of Social Science." Unpublished doctoral dissertation, University of California, California. 1969. 226 pp.

Cullen, Lola F. "Nonverbal Communication in Counselling: An Exploratory Study." Unpublished doctoral dissertation, University of Southern California, California. 1966. 267 pp.

Cureton, Edward E. "Validity." In Lindquist, E. F. (Ed.), Educational Measurement. Washington, D.C.: American Council on Education. 1961. pp. 621-694.

DeVore, Paul W. "Technology: A Structure for Industrial Arts Content." In American Industrial Arts Annual Convention Addresses and Proceedings, New Directions for Industrial Arts. Washington, D.C.: American Industrial Arts Association, National Education Association. 1964. pp. 78-80

DeVore, Paul W. Structure and Content: Foundations for Curriculum Development. Washington, D.C.: American Industrial Arts Association, National Education Association. 1966. 21 pp.

DeVore, Paul W. "Curricular Considerations--Oswego." In American Industrial Arts Annual Convention Addresses and Proceedings, Industrial Arts and Technology--Past, Present, and Future. Washington, D.C.: American Industrial Arts Association, National Education Association. 1967(a). pp. 12-18.

DeVore, Paul W. "Knowledge--Technology and Curriculum." In American Industrial Arts Annual Convention Addresses and Proceedings, Industrial Arts and Technology--Past, Present, and Future. Washington, D.C.: American Industrial Arts Association, National Education Association. 1967(b). pp. 41-54.

DeVore, Paul W. "Discipline Structures and Processes--A Research Design for Content and Method." In American Industrial Arts Annual Convention Addresses and Proceedings, Where the Action Is. Washington, D. C.: American Industrial Arts Association, National Education Association. 1969(a). pp. 75-83.

DeVore, Paul W. "Factors Affecting Curriculum Design." In Industrial Arts Association of Pennsylvania Proceedings. Pittsburgh, Pennsylvania: Rockville Manufacturing Company. 1969(b). pp. 1-3.

DeVore, Paul W. "The Nature of Technology." In American Industrial Arts Annual Convention Addresses and Proceedings, Man--Society--Technology. Washington, D.C.: American Industrial Arts Association, National Education Association. 1970. pp. 113-119.

Drucker, Peter F. "Work and Tools." Technology and Culture. Winter, 1960. 1: 29-37.

Drucker, Peter F. "Technological Trends in the Twentieth Century." In Kranzberg, Melvin, and Pursell, Carroll, Jr. (Eds.), Technology in Western Civilization. Vol. II. New York, New York: Oxford University Press. 1967. pp. 10-22.

Ellul, Jacques. The Technological Society. New York, New York: Random House. 1964. 449 pp.

Evans, Thomas Parker, "An Exploratory Study of the Verbal and Nonverbal Behavior of Biology Teachers and Their Relationships to Selected Personality Traits." Unpublished doctoral dissertation, Ohio State University, Ohio. 1968. 276 pp.

Face, Wesley L. "The American Industry Project." In American Industrial Arts Annual Convention Addresses and Proceedings, Industrial Arts and Technology--Past, Present, and Future. Washington, D.C.: American Industrial Arts Association, National Education Association. 1967. pp. 18-19.

Face, Wesley L., and Flug, Eugene R. "Conceptual Approach to the Study of American Industry." In American Industrial Arts Annual Convention Addresses and Proceedings, Developing Human Potential through Industrial Arts. Washington, D.C.: American Industrial Arts Association, National Education Association. 1965. pp. 115-120.

Fay, Paul J., and Middleton, Warren C. "Judgement of Occupation from the Voice Transmitted over a Public Address System and over a Radio." Journal of Applied Psychology. 1939. 23: 586-601.

Fay, Paul J., and Middleton, Warren C. "Judgement of Kretechmerian Body Types from the Voice Transmitted over a Public Address System." Journal of Social Psychology. November, 1940. 12: 151-162.

Fay, Paul J., and Middleton, Warren C. "The Ability to Judge Truth-Telling or Lying from the Voice Transmitted over a Public Address System." Journal of General Psychology. January, 1941(a). 24: 211-215.

Fay, Paul J., and Middleton, Warren C. "The Ability to Judge Sociability from the Voice Transmitted over a Public Address System." Journal of Social Psychology. February, 1941(b). 13: 303-309.

Fay, Paul J., and Middleton, Warren C. "Judgement of Leadership from Transmitted Voice." Journal of Social Psychology. February, 1943. 17: 99-102.

Flug, Eugene R. "The American Industry Project." Paper presented at the American Vocation Association Convention, Denver, Colorado. December, 1966. 12 pp.

Franklin, Margery, and Jobb, Judith. An Experimental Approach to Study Nonverbal Representation in Young. (Head Start Evaluation and Research Center, Progress Studies 1966 to 1967: Document 3) Washington, D.C.: U.S. Government Printing Office. 1967. 14 pp.

French, Russel Lee. "A Study of Communication Events and Teacher Behavior: Verbal and Nonverbal." Unpublished doctoral dissertation, Ohio State University, Ohio. 1968. 177 pp.

Gagné, Robert M. "Problem Solving and Thinking." Annual Review of Psychology. 1959. 10: 147-172.

Gagné, Robert M. "The Acquisition of Knowledge." Psychological Review. July, 1962. 69(4): 355-365.

Gagné, Robert M. "Problem Solving." In Melton, Arthur (Ed.), Categories of Human Learning. New York, New York: Academic Press. 1964. pp. 293-317.

Gagné, Robert M. The Conditions of Learning (1st ed.) New York, New York: Holt, Rinehart, and Winston, Inc. 1965. 308 pp.

Gagné, Robert M. "Contributions of Learning to Human Development." Psychological Review. 1968(a). 75(3): 177-191.

Gagné, Robert M. "Learning Hierarchies." Educational Psychologist. (Department of Education and Psychology, Purdue University, Lafayette, Indiana) 1968(b). 6(1): 1-9.

Gagné, Robert M. "Context, Isolation, and Interference Effects on the Retention of Fact." Journal of Educational Psychology. October, 1969. 60(5): 408-414.

Gagné, Robert M. (Ed.) Basic Studies of Learning Hierarchies in School Subjects. (United States Department of Health, Education, and Welfare, Office of Education, Bureau of Research) Washington, D.C.: U. S. Government Printing Office. April, 1970(a). 92 pp.

Gagné, Robert M. The Conditions of Learning. (2nd ed.) New York, New York: Holt, Rinehart, and Winston, Inc. 1970(b). 407 pp.

Gagné, Robert M. "The Learning of Concepts." In Clarizio, Harvey F.; Craig, Robert C.; and Mehrens, William A. (Eds.), Contemporary Issues in Educational Psychology. Boston, Massachusetts: Allyn and Bacon, Inc. 1970(c). pp. 230-237.

Gagné, Robert M. "Some New Views of Learning and Instruction." Phi Delta Kappan. May, 1970(d). 51(9): 468-472.

Gagné, Robert M. "Instruction Based on Research in Learning." Engineering Education. March, 1971. 61(6): 519-523.

Gagné, Robert M., and Basseler, Otto C. "Study of Retention of Some Topics of Elementary Non-metric Geometry." Journal of Educational Psychology. June 1963. 54(3): 123-131.

Gagné, Robert M., and Brown, Larry T. "Some Factors in the Programming of Conceptual Learning." Journal of Experimental Psychology. October, 1961. 62(4): 313-321.

Gagné, Robert M.: Mayor, John R.; Garstens, Helen L; and Paradise, Noel E. "Factors in Acquiring Knowledge of a Mathematical Task." Psychological Monograph. 1962. 76(7, Whole No. 526).

Gagné, Robert M., and Okey, James R. "Revision of a Science Topic Using Evidence of Performance on Subordinate School Subjects." In Gagné, Robert M. (Ed.), Basic Studies of Learning Hierarchies in School Subjects. (United States Department of Health, Education and Welfare, Office of Education, Bureau of Research) Washington, D.C. : U. S. Government Printing Office. April, 1970. pp. 44-57.

Gagné, Robert M., and Paradise, Noel E. "Abilities and Learning Sets in Knowledge Acquisition." Psychological Monograph. 1961. 75(14, Whole No. 518).

Gagné, Robert M., and Smith, Ernest C. "A Study of the Effects of Verbalization on Problem Solving." Journal of Experimental Psychology. 1962. 63(1): 12-18.

Gagné, Robert M., and staff. "Some Factors in Learning Non-metric Geometry." Monograph of the Society for Research in Child Development. 1963. 30(1): 42-49.

Gagné, Robert M., and Wiegand, Virginia K. "Some Factors in Children's Learning and Retention of Concrete Rules." Journal of Educational Psychology. 1968. 59(5): 355-361.

Gagné, Robert M., and Wiegand, Virginia K. "Effects of a Superordinate Context on Learning and Retention of Facts." Journal of Educational Psychology. October, 1970. 61: 406-409.

Galloway, Charles M. "An Exploratory Study of Observational Procedure for Determining Teachers Nonverbal Communication." Unpublished doctoral dissertation, University of Florida, Florida. 1962. 137 pp.

Galloway, Charles M. "Teachers Nonverbal Communication." Educational Leadership. October, 1966. 24: 55-63.

Galloway, Charles M. "Nonverbal Communication in the Classroom." Paper presented to the AACTE Workshop, Ohio State University, Ohio. 1967. 14 pp. (ERIC Microfiche No. EC-011-891).

Galloway, Charles M. "A Workshop in the Analysis of Teaching: Interaction Analysis, Nonverbal Communication, and Microteaching." Theory and Practice. December, 1968(a). 7(5): 157.204.

Galloway, Charles M. "Nonverbal Communication: A Needed Focus." Unpublished paper, Ohio State University, Ohio. 1968(b). 6 pp. (ERIC Microfiche No. ED-025-484).

Galloway, Charles M., and French, Russel L. "A Description of Teacher Behavior: Verbal and Nonverbal." Paper presented at Ohio State University, Ohio. 1968(a). 9 pp. (ERIC Microfiche No. ED-028-134).

Galloway, Charles M., and French, Russel L. "Communication Events: A New Look at Classroom Interaction." Paper presented at Ohio State University, Ohio. 1968(b). 9 pp. (ERIC Microfiche No. ED-026-293).

Gibson, Jeanne R. "Transfer Effects of Practice Variety in Principle Learning." Unpublished doctoral dissertation, University of California, California. 1969. 141 pp.

Greenspoon, Joel. "The Reinforcing Effect of Two Spoken Sounds on the Frequency of Two Responses." American Journal of Psychology. June, 1955. 68(2): 409-416.

Hastings, James. (Ed.) Field Study in Industry for the Preparation of Industrial Arts Teachers. Vol. I. (United States Office of Education, Bureau of Research) Washington, D.C.: U. S. Government Printing Office. August, 1967. pp. 20-33.

Heger, Hebert K. "Analyzing Verbal and Nonverbal Classroom Communications." Paper presented at Ohio State University, Ohio. 1968 12 pp. (ERIC Microfiche No. ED-025-483).

Heger, Hebert K. "Verbal and Nonverbal Classroom Communication: The Development of an Observation Instrument." Unpublished doctoral dissertation, Ohio State University, Ohio. 1969. 98 pp.

Hendrix, Gertrude. "Learning by Discovery." The Mathematics Teacher. May, 1961. 54(5): 290-299.

Hirsch, Jerry. "Learning Without Awareness and Extinction Following Awareness as a Function of Reinforcement." Journal of Experimental Psychology. February, 1957. 53(2): 218-224.

Hurst, Rex L. "Qualitative Variables in Regression Analysis." American Educational Research Journal. 1970. 7(4): 541-552.

Island, Donald D. "The Development and Analysis of Categories of Nonverbal Behavior of Counselors in Filmed Interviews." Unpublished doctoral dissertation, University of Minnesota, Minnesota. 1966. 273 pp.

Israel, Everett N. "A Study of Interpersonal Nonverbal Communication in General Industrial Arts Laboratories." Unpublished master's thesis, University of Maryland, Maryland. 1966. 202 pp.

Israel, Everett N. "A Taxonometric Study of Communication." Paper presented to Board of Education, Dracut Public Schools, Dracut, Massachusetts. 1967(a). 16 pp.

Israel, Everett N. "Thoughts, Facts, and Ideas about Nonverbal Communication." Paper presented at State College at Fitchburg, Massachusetts. 1967(b). 12 pp.

Jones, Elwyn. "Thermoforming." In Modern Plastics Encyclopedia, 1970-1971. New York, New York: McGraw-Hill. October, 1971. pp. 602-630.

Kanawha County Planning and Zoning Commission. Regional Traffic and Arterial Study. Charleston, West Virginia: Author. 1964(a). Pages by Chapters.

Kanawha County Planning and Zoning Commission. Regional Traffic and Arterial Study: Coding Index. Charleston, West Virginia: Author. 1964(b). Pages by Divisions.

Kostur, Robert. "Vacuum Forming." Modern Plastics Encyclopedia Issue for 1965. New York, New York: McGraw-Hill. September, 1964. pp. 648-651.

Kranzberg, Melvin, and Pursell, Carroll W., Jr. "The Importance of Technology in Human Affairs." In Kranzberg, Melvin, and Pursell, Carroll W., Jr. (Eds.), *Technology in Western Civilization.* Vol. I. New York, New York: *Oxford University Press. 1967. pp.* 3-11.

Larson, Donald E. "Nonverbal Communication: Its Function for Counselor-Trainee in the Formation of Clinical Impressions." Unpublished doctoral dissertation, University of Oregon, Oregon. 1969. 143 pp.

Lindbeck, John R., and Lathrop, Irvin T. *General Industry*. Peoria, Illinois: Charles A. Bennett Co., Inc. 1969. 333 pp.

Masson, Don (Ed.) *The Story of the Plastics Industry*. New York, New York: The Society of the Plastics Industry. February, 1970. 41 pp.

McConnell, William, Jr. "Thermoforming." In *Modern Plastics Encyclopedia Issue for 1968*. New York, New York: McGraw-Hill. September, 1967. pp. 812-823.

McConnell, William, Jr. "Thermoforming." In *Modern Plastics Encyclopedia, 1969-1970*. New York, New York: McGraw-Hill. October, 1970. pp. 534-563.

McCormick, Ernest J. *Human Factors Engineering*. (3rd ed.) New York, New York: McGraw-Hill Book Co. 1970. 639 pp.

McKee, Geoffrey R. "Effects of Verbal and Nonverbal Stimuli on Subjects' Verbal Production in a Counseling Experiment." Unpublished doctoral dissertation, University of Missouri, Missouri. 1969. 84 pp.

Nunnally, Jim C., Jr. "Methods for Determining the Scientific Usefulness of Psychological Measures." *Introduction to Psychological Measurement*. New York, New York: McGraw-Hill. 1970. pp. 105-229.

Olson, Delmar, W. *Technology and Industrial Arts*. Columbus, Ohio: Epsilon Pi Tau, Inc. 1957. 256 pp.

Olson, Delmar W. *Industrial Arts and Technology*. Englewood Cliffs, New Jersey: Prentice-Hall. 1963. 367 pp.

Philbrick, Emily B., and Postman, Leo. "A Further Analysis of 'Learning Without Awareness'." *American Journal of Psychology*. June, 1955. 68(2): 417-424.

Ruesch, Jurgen. "Synopsis of the Theory of Human Communication." Psychiatry. August, 1953. 16: 215-243.

Ruesch, Jurgen. "Nonverbal Language and Therapy." Psychiatry. November, 1955. 18: 323-330.

Ruesch, Jurgen. "The Observer and the Observed: Human Communication Theory." In Grinker, Roy Richard, and Hughes, Helen MacGill (Eds.), Toward a Unified Theory of Human Behavior. New York, New York: Basic Books, Inc. 1956. pp. 36-54.

Ruesch, Jurgen. Therapeutic Communication. New York, New York: Norton and Company, Inc. 1961. pp. 451-468.

Ruesch, Jurgen, and Bateson, Gregory. Communication: The Social Matrix of Psychiatry. New York, New York: Norton and Company, Inc. 1951. 314 pp.

Ruesch, Jurgen, and Kees, Weldon. Nonverbal Communication. Berkeley and Los Angeles, California: University of California Press. 1961. 192 pp.

Shusler, Richard A. "Nonverbal Communication in Elementary School Classrooms." Unpublished doctoral dissertation, University of Missouri, Missouri. 1969. 176 pp.

Shannon, Claude E., and Weaver, Warren. The Mathematical Theory of Communication. Urbana, Illinois: The University of Illinois Press. 1949. pp. 1-12.

Smith, M. Daniel, and Bolyard, A. Joyce. The Interaction of Words and Graphic Symbols Investigated Via a Programmed Sequence of Concept Experiences Related to Vector Spaces. (United States Office of Education). Washington, D.C.: U. S. Government Printing Office. 1965. 32 pp. (ERIC Microfiche No. ED-010-540).

Society of the Plastics Industry. Plastic Engineering Handbook. New York, New York: Rinehold. 1960. pp. 91-117.

Thorndike, Robert L. "Reliability." In Lindquist, E. F. (Ed.), Educational Measurement. Washington, D.C.: American Council on Education. 1961. pp. 560-620.

Torkelson, Gerard M. (Ed.) "Instructional Materials: Educational Media and Technology." Review of Educational Research. April, 1968. 38(2): 111-194.

Towers, Edward R.; Lux, Donald G,; and Ray, Willis E. New Dimensions in Industrial Arts Curriculum Development: A Brief Description of the Industrial Arts Curriculum Project. Columbus, Ohio: Industrial Arts Curriculum Project, Ohio State University. 1966. 25 pp.

Travers, Robert M. (Ed.) Research and Theory Related to Audio-Visual Information Transmission. (United States Office of Education, Interim Report, Bureau of Research) Washington, D.C.: U. S. Government Printing Office. July, 1964. Pages by Chapters.

Travers, Robert M., and others. Studies Related to the Design of Audio-Visual Materials. (United States Office of Education, Final Report, Bureau of Research) Washington, D.C.: U. S. Government Printing Office. May, 1966. 271 pp.

Van Matre, Gene L. J. "The Influence of Nonverbal Mode of Information on Counselor Ratings of Warmth and Genuineness." Unpublished doctoral dissertation, University of Missouri, Missouri. 1969. 109 pp.

Waetjen, Walter. "How We Learn." Industrial Arts and Vocational Educational Education. December, 1964. 53: 16-17.

Warner, William E. Newsletter: 1929-1970. Columbus, Ohio: Epsilon Pi Tau, Inc. 1970(a). 4 pp.

Warner, William E. Record of Epsilon Pi Tau. Columbus, Ohio: Epsilon Pi Tau, Inc. 1970(b). 4 pp.

Weiss, Robert L. "The Influence of 'Set of Speed' on 'Learning Without Awareness'." American Journal of Psychology. June, 1955. 68(2): 425-431.

Wertheimer, Max. Productive Thinking. New York, New York: Harper and Brothers. 1945. 224 pp.

Weigand, Virginia K. "The Study of Subordinate Skills in Science Problem Solving." Unpublished doctoral dissertation, University of California, California. 1969. 121 pp.

Wilber, Gordon O., and Pendered, Norman C. Industrial Arts in General Education. Scranton, Pennsylvania: International Textbook Co. 1967. 403 pp.

Woodruff, Asahel D. "The Use of Concepts in Teaching and Learning." Journal of Teacher Education. March, 1964. 15: 81-99.

Worth, Sol. "The Development of a Semiotic of Film." Unpublished paper. 1968. 62 pp. (ERIC Microfiche No. ED-031-945).

APPENDIX A

CRITERIA FOR SELECTING A TECHNICAL PRINCIPLE

CRITERIA FOR SELECTING A TECHNICAL PRINCIPLE

The criteria for evaluating and selecting a principle are:

The technical principle will

- meet the criteria of a rule (principle) as defined by Gagné,
- be technically based,
- have general application
- include attributes (concrete concepts) that can be operationally defined,
- be one that can be presented to students during one class period (45 to 55 minutes),
- be one which most junior and senior high school boys would not have been exposed to,
- lend itself to the "learn by doing" approach as well as the conceptual approach, and
- be structured at the student's general cumulative cognitive developmental level.

An explanation of the first criteria involves describing the characteristics of concrete concept and rule (principle) learning. The description will identify the relationship between concrete concept and rule learning.

Concrete concept learning involves:

- the learner having experienced verbal association, discrimination, and/or chaining,
- the learner making a general response to a class of observable environmental stimuli,
- the learner using a word to describe the common property used to classify environmental stimuli,
- the meaning of the concept name describing the common property used to classify environmental stimuli,
- the concept name being applied to a variety of situations in which the abstraction occurs,

- the learner being able to classify a new example of an environmental happening as a member of a concrete concept class, when applicable (universal knowledge about a concrete concept class such as how it relates to other concrete concepts, how it functions, are usually classified as rules), and
- concrete concept names freeing the learner from the control of environmental stimuli.

Rule learning:

- includes concepts that cannot be learned by the previously described process;
- (a) relational concepts such as mass, temperature, aunt, uncle, and casting, and (b) principles: knowledge statements which have been previously defined in a predetermined manner;
- involves combining concrete and/or relational concepts;
- involves knowledge which has general application to a number of similar but different situations;
- is the learner's cognitive understanding of relational, joined relational and/or concrete concepts;
- involves the learner's understanding of relational concepts, joined relational and/or concrete concepts and principles accounting for the regularity of his behavior in a given situation as well as in a variety of infinitely related situations;
- involves the learner developing an abstract (verbal) understanding of the meaning of relational concepts, joined concrete and/or relational concepts, and principles;
- enables the learner to engage in thinking;
- involves a major classification of a type of learning which does not attempt to organize rules in any given order (the theme of the topic identifies the purpose of a subordinate hierarchy or hierarchy of rules);
- involves adults being more dependent upon the recall of previously learned rules, concrete concepts, and/or relational concepts to develop a new rule.

APPENDIX B

SURVEY FORM USED TO SELECT A TECHNICAL PRINCIPLE

SURVEY FORM USED TO SELECT A TECHNICAL PRINCIPLE

Directions: Cross out any principles that you feel don't meet the criteria previously identified. Feel free to add any which you feel should be included.

Rank the principles in the space provided. Principles which you feel are equal in rank should be given the same rating: i.e., six principles which you feel are equal in rank should be assigned the same number.

_____ Principle: Fluidized-Bed Coating
Definition: A plastic coating applied to a material by dipping a pre-heated object into a solid (plastic powder) made to act as a fluid by the flow of air.

_____ Principle: Cohesive Bonding
Definition: A plastic fastening process whereby the molecular attraction of two similar materials are united to become one mass by the use of thermo welding and/or solvent cementing.

_____ Principle: Reinforcing Plastics
Definition: A process whereby either a thermoplastic or thermosetting resin is combined with a non-plastic fibrous material to produce a product having greater strength than the single components.

_____ Principle: Thermoforming
Definition: A process of bringing a non-plastic sheet material to a state of plasticization, stretching the non-plastic sheet by air or vacuum to the shape of a cavity or mold, and allowing the plasticized material to set.

_____ Principle: Extrusion
Definition: A process whereby a thermoplastic material is compressed and transformed into a homogenous melt which is forced through dies to form tubes, rods, films, and other irregular shapes.

____ Principle: Injection Molding
Definition: A cyclical process of forcing a plasticized thermoplastic into a mold cavity. When the plastic has become set it retains the shape of the mold.

____ Principle: Rotation Molding
Definition: A process whereby vinyl thermoplastic granules are suspended in a plastisol and placed in an enclosed mold. The plastic is exposed to heat while rotating biaxially, thus forcing the liquid against the mold.

____ Principle: Photographic Silkscreen
Definition: A process of stencil printing which involves the use of photography to make the stencil.

____ Principle: Electrostatic Printing
Definition: A process involving the use of photo-conductive sensitive plate or solution to produce a latent image. The image is developed by the charged areas attracting a fine granulated powder.

____ Principle: Interchangeable Parts
Definition: The mass production of goods by the use of dimensional control involving the use of jigs, fixtures, templates, and standardized procedures.

____ Principle: Ball Memory Control Device
Definition: The use of a ball located in a drum groove to store data until some other type of action is taken.

____ Principle: Electromagnetic Metal Forming
Definition: The use of a rapidly expanding magnetic field to produce a desired deformation in the surface of a metallic work piece.

____ Principle: Automation (Industrial Robot)
Definition: The transfer of a product by a stationary or moveable automatically-controlled manipulator programmed to perform repetitive production operations.

____ Principle: Nonstable Controllable Platform
Definition: A platform designed to sustain and maintain controllable flight through the combined use of power, elevators, ailerons, and rudders.

____ Principle: Steam Propulsion
Definition: The process of converting steam into mechanical energy.

____ Principle: Energy Conversion
Definition: The process of changing energy from one form to another through the medium of some technical device.

____ Principle: ________________________________
Definition: ________________________________
____
____
____
____

____ Principle: ________________________________
Definition: ________________________________
____
____
____
____

APPENDIX C

GUIDELINES USED FOR DEVELOPING A SUBORDINATE HIERARCHY

GUIDELINES USED FOR DEVELOPING A SUBORDINATE HIERARCHY

Guidelines for Developing the Subordinate Hierarchy

- The following question is asked of the final task and each subordinate task: "What would the individual already have to know how to do in order to learn this new capability simply by being given verbal instructions?"

- The hierarchy is concerned with the development of intellectual skills:

distinguish
reformulate
generate
translate
summarize
order
formulate
predict
describe
test
identify
construct
specify
perform
derive
assign
infer
name
transform
simplify
supply
measure
find
observe
classify
interpret
etc.

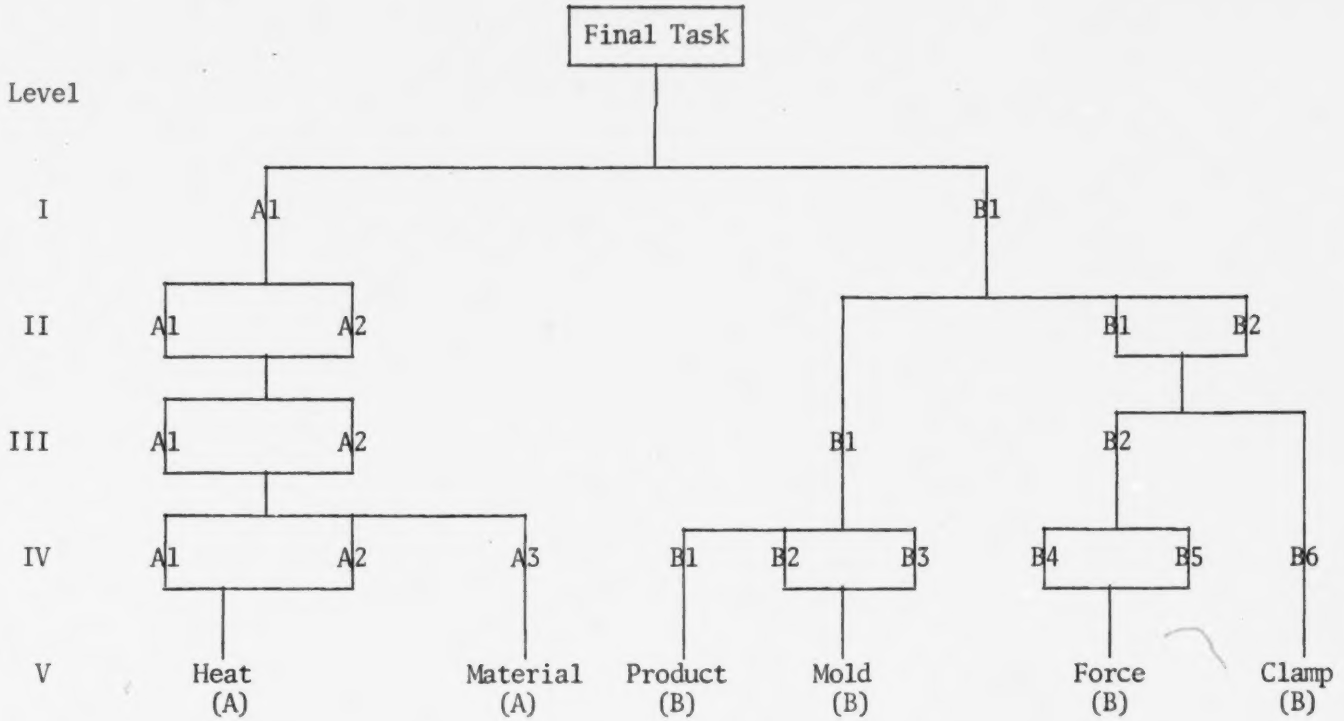
Characteristics of a Subordinate Hierarchy

- Each higher hierarchical level builds upon the lower adjacent level.
- Each hierarchical level is concerned with the same degree of complexity.
- A hierarchy is organized psychologically, not logically.
- A hierarchy consists of more than verbal knowledge.
- A hierarchy is concerned with determining intradependency and interdependent relationships between concrete and relational concepts.
- More than one hierarchy may be developed related to a specific final task.
- The effectiveness of a hierarchy is determined by positive transfer.
- The hierarchy is designed as the most probable route for a group of students to acquire a rule.
- Individual students may skip subordinate tasks as the result of past knowledge they have already acquired.
- A hierarchy does not represent everything that can be learned about the final task.

APPENDIX D

INITIAL SUBORDINATE HIERARCHY

INITIAL SUBORDINATE HIERARCHY


Final Task
Level
I
II
III
IV
V
A1
B1
A1
A2
B1
B2
A1
A2
B1
B2
A1
A2
A3
B1
B2
B3
B4
B5
B6
Heat
(A)
Material
(A)
Product
(B)
Mold
(B)
Force
(B)
Clamp
(B)

Level	Task
IVA1	Identify that conduction and convection are two different ways of heating a material
IVA2	Identify that temperature is a measure of the intensity of heat
IVA3	Identify that different types of materials come in sheets
IIIA1	Identify that the same heat intensity level has different effects on different kinds of materials
IIIA2	Identify that the same heat intensity has a different effect on thermoplastic plastic sheets than on thermosetting plastic sheets
IIA1	Identify that different heat intensities have a different effect on the softness of thermoplastic plastic sheets - Too hot--blisters - Shaping temperature--flexible and stretches - Draping temperature--flexible and rubbery
IIA2	Identify that the lack of heat results in thermoplastic plastic sheets becoming rigid or set
IA1	Identify that the lack of or presence of different heat intensities has an effect on the rigidity or softness of thermoplastic plastics
IVB1	Identify that shape is the outline of a product which includes the length, width, height, and contour of a product
IVB2	Identify that two types of molds are protruding and recessed
IVB3	Identify that the draft of a mold allows the product to be removed from a mold
IVB4	Identify that force is the amount of push exceeding the amount of resistance
IVB5	Identify that vacuum and compressed air can be used to exert a force

IVB6	Identify that a clamp exerts a mechanical force
IIIB1	Identify that different molds can be used to produce the shape of different products
IIIB2	Identify that an air-tight chamber is needed for air or vacuum to exert a force
IIB1	Identify that vacuum and air can be used to stretch a material
IIB2	Identify that the stretching of a material requires the clamping mechanism to (a) exert a pressure greater than the force being used to stretch the material, (b) hold the material in place, and (c) produce an air-tight chamber
IB1	Identify that the use of force to stretch and hold a material against a mold is forming

APPENDIX E

GUIDELINES USED FOR CONSTRUCTING TEST MATERIALS

GUIDELINES USED FOR CONSTRUCTING TEST MATERIALS

Final Task Test

Purpose:

- To measure the students' capabilities to identify and order the major attributes of thermoforming.

Guidelines for Structuring Test:

- The final task should require students to order the subordinate subtasks for the first time.
- The final task should require students to identify the component concrete and relational concepts used to formulate the rule.
- The final task should require students to demonstrate how the relational and concrete concepts relate with each other in formulating the rule.
- The ability of students to state the rule verbally does not mean that they understand the rule.
- The final task stimulus situation should be different from the situations that were used for students to learn the prerequisited concepts.
- The final task should consist of performances expected of students as the result of them having acquired previous prerequisited concepts.

Instructions:

- The directions must inform the students of the nature of the performance expected.
- The final task should be stated in such a way that students can recall previously acquired attributes.

Transfer Test

Purpose:

- To measure the amount of understanding students have acquired about thermoforming.

Guidelines for Structuring Test:

- The test must be contextually related to the final task.
- The test must require students to apply their understanding of thermoforming to solve a novel, contextually-related problem.

Instructions:

- The directions must inform the students of the nature of the performance expected.
- The transfer task should be stated in such a way that students can recall their understanding of thermoforming and its attributes.

Learning Achievement Test

Purpose:

- To determine the subordinate hierarchical level students have achieved.
- To determine the amount of verbal knowledge students acquired.
- To determine the amount of positive transfer.

Guidelines for Structuring Test:

- Each question is constructed to measure the students' ability to complete a specific subordinate hierarchical task.
- More than one question can be used per subordinate task.
- The questions should be ordered from the lowest to the highest subordinate level when the learning set test is being used to measure positive transfer.

Instructions:

- Inform students of the nature of the performance expected.

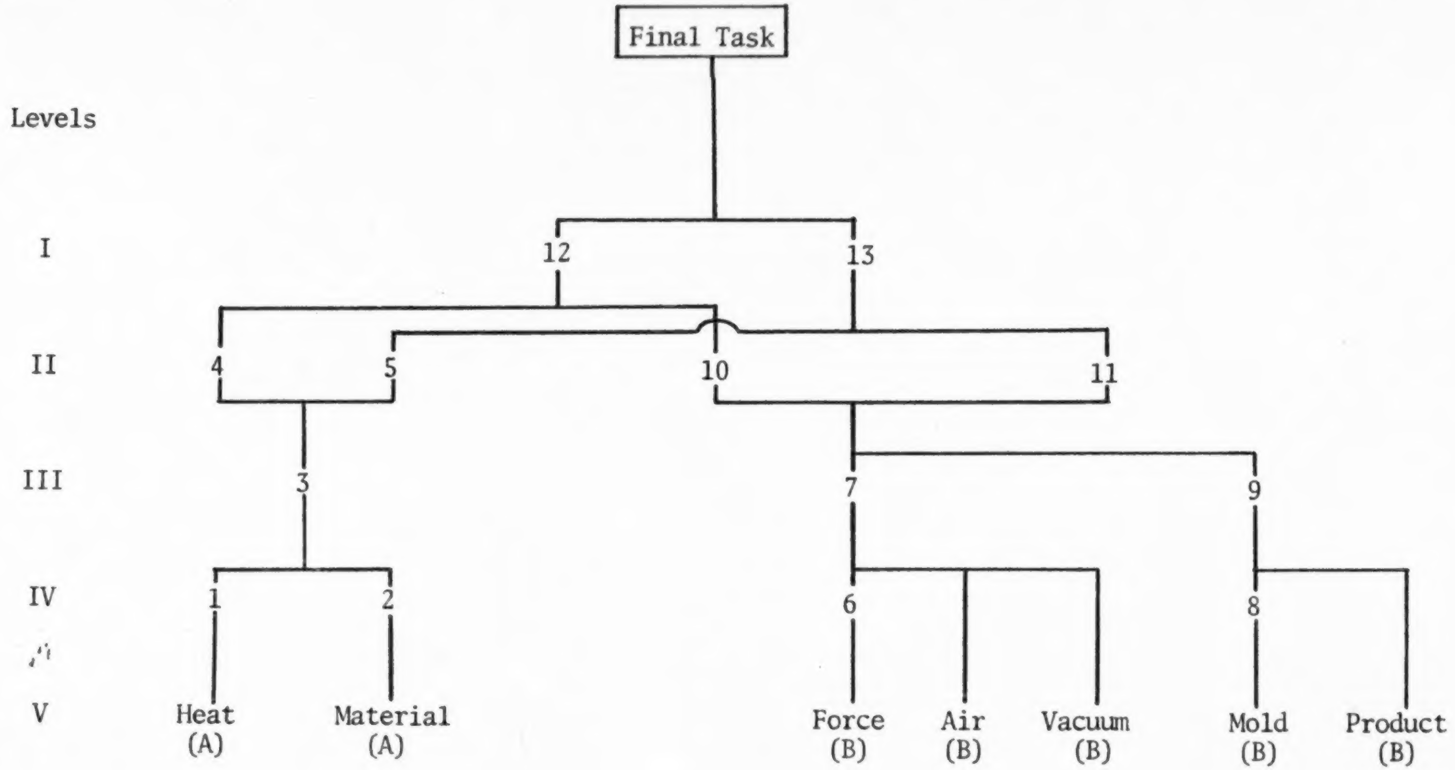
APPENDIX F

SUBORDINATE HIERARCHY USED TO CONDUCT STUDY

(Learning Task Diagram)

I-A

LEARNING TASK DIAGRAM


Final Task
Levels
I
II
III
IV
V
12
13
4
5
10
11
3
7
9
1
2
6
8
Heat (A)
Material (A)
Force (B)
Air (B)
Vacuum (B)
Mold (B)
Product (B)

Branch	Level	Task No.	Subordinate Task
A	IV	1	Identify that heating a material describes the process of raising the temperature of the material.
A	IV	2	Identify that different kinds of materials can be classified as sheets when their thickness is less than their width and length.
A	III	3	Identify that heat causes thermoplastic plastic sheets to become soft.
A	II	4	Identify that thermoplastic plastic sheets heated to their shaping temperature can be stretched.
A	II	5	Identify that cooling causes thermoplastic plastic sheets to become set.
B	IV	6	Identify that force, defined as work, requires the amount of push or pull to be greater than the amount of resistance.
B	III	7	Identify that air or vacuum can be used to exert a force.
B	IV	8	Identify that a mold serves as an inside or outside model for making an item.
B	III	9	Identify that shape, which is produced by a mold, includes the thickness, width, length, and surface detail of a product.
B	II	10	Identify that air or vacuum can be used to exert a force which will stretch sheet materials against a mold.
B	II	11	Identify that air or vacuum can be used to hold stretched sheet materials against a mold.
B	I	12	Identify that air or vacuum will exert a force which will stretch heated thermoplastic sheets against a mold.
B	I	13	Identify that air or vacuum will hold stretched thermoplastic plastic sheets against a mold while they set.

APPENDIX G

OBJECTIVES PER SUBORDINATE HIERARCHICAL LEVEL AND TASK USED TO PREPARE THE NV + V_c AND V TREATMENTS

OBJECTIVES PER SUBORDINATE HIERARCHICAL LEVEL AND TASK USED TO PREPARE THE NV + V_c AND V TREATMENTS

Definition of Thermoforming

Thermoforming was defined as the process of heating a thermoplastic plastic sheet to its shaping temperature, stretching the hot sheet against a mold by the use of air and/or vacuum to exert a force, and using air and vacuum to hold the material against the mold until the plastic has set.

Subordinate Hierarchy

The subordinate hierarchy includes five levels plus the final task. Level V is concerned with the past learning experiences the students have acquired related to thermoforming. Levels IV through I are concerned with outlining a means for the students to acquire an abstract understanding of thermoforming.

At level V, seventh and eighth grade students will be familiar with some of the concrete and relational verbal concept terms that will be used in the lessons to describe thermoforming. The students will not have acquired a verbal understanding of the interrelationships between the concepts as they relate to thermoforming.

The presentation of and the students' completion of the subordinate hierarchical tasks related to levels IV - I will result in the students acquiring a verbal understanding of the interrelationships between relational and concrete concepts as they relate to thermoforming. Specific objectives per level are:

Objectives Per Subordinate Hierarchical Level

Level IV:	The students will identify attributes of the concepts at level V as they relate to thermoforming (Positive Transfer Test.)
Level III:	The students will identify general rules which explain interrelationships between the attributes of the concepts as they relate to thermoforming (Positive Transfer Test.)
Level II:	The students will identify discriminating attributes of the above interrelationships as they relate to thermoforming (Positive Transfer Test.)
Level I:	The students will identify rules for interrelating the discriminating attributes of the thermoforming (Positive Transfer Test.)

The students' acquired verbal understanding of the interrelationships among thermoforming subconcepts (Levels IV - I) will enable them to determine a procedure for the production of a thermoformed product. This task will result in the students acquiring a verbal understanding of thermoforming (Final Task Test.)

The students' acquired verbal understanding of thermoforming will enable them to identify thermoforming and non-thermoforming processes (Transfer Task Test.)

The students' understanding of the interrelationships among concepts and their ability to identify thermoforming and non-thermoforming processes will result from the knowledge they have acquired per subordinate task (Learning Achievement Test.)

Objectives and Instructions per Subordinate Task

Level and Task	Objectives the Student Will Identify	Instruction
Level IV, Task 1	Heating a material describes the process of raising the temperature of the material.	-Heat is a process. -Heat raises the warmth of a material. -Warmth is measured by a thermometer. -A thermometer measures temperature. -Temperature is the degree of warmth or "hotness" of a material.
Level IV, Task 2	Different kinds of materials can be classified as sheets when their thickness is less than their width and length.	-There are different kinds of materials. -Different materials come in different forms (bar, sheet, rod, tube, block). -Materials in sheets are flat - the thickness is less than the width and length.
Level III, Task 3	Heat causes thermoplastic plastic sheets to become soft.	-Heat has a different effect on different kinds of sheet materials. -Heat causes thermoplastic plastic sheets to become soft. -Thermo------------plastic--------plastic (Heat) (Flexible by softening) (Kind of material)
Level II, Task 4	Thermoplastic plastic sheets heated to their shaping temperature can be stretched.	-Thermoplastic plastic sheets not heated to their shaping temperature will be flexible but can't be stretched. -Thermoplastic plastic sheets heated to their shaping temperature can be stretched. -Thermoplastic plastic sheets heated above their shaping temperature will blister.

Level II, Task 5	Cooling causes thermoplastic plastic sheets to become set.	-Thermoplastic plastic sheets become rigid when cooled. -Stretched thermoplastic sheets take on the shape they were held in while they were cooled. -Word used to describe this condition is "set."
Level IV, Task 6	Force, defined as work, requires the amount of push or pull to be greater than the amount of resistance.	-Work to be done is defined as resistance. -Push or pull must exceed resistance in order for work to be done. -Force, defined as work, is the amount of push or pull being greater than resistance.
Level III, Task 7	Air or vacuum can be used to exert a force.	-Air compressed in an air-tight chamber can be used to exert a force that will exceed resistance. -The absence of air in an air-tight chamber and presence of atmospheric pressure can be used to exert a force that will exceed resistance.
Level IV, Task 8	A mold serves as an inside or outside model for making an item.	-A mold is an object which is similar to the product being produced from it. -The similarity of a mold to the product can best be described by stating that the mold was a "model" for making the product. -A mold can be the inside or outside pattern of a product.

Level III, Task 9	Shape, which is produced by a mold, includes the thickness, width, length, and surface detail of a product.	-The shape of a product is related to the shadow of a product. -A shadow includes the width, thickness, length, and surface detail of the product. -The shape of a product includes the width, thickness, length, and surface detail of a product.
Level II, Task 10	Air or vacuum can be used to exert a force which will stretch sheet materials against a mold.	-Air and vacuum can be used to exert a force. -Force can be used to stretch some sheet materials against a mold. -The stretched material will conform to the shape of the mold.
Level II, Task 11	Air or vacuum can be used to hold stretched sheet materials against a mold.	-Trapped compressed air in an air-tight chamber will hold stretched sheet materials against a mold. -Maintaining the absence of air in an air-tight chamber and the presence of atmospheric pressure will hold stretched materials against a mold.
Level I, Task 12	Air or vacuum will exert a force which will stretch heated thermoplastic plastic sheets against a mold.	-A thermoplastic plastic sheet heated to its shaping temperature can be stretched. -Vacuum or air can be used to stretch heated thermoplastic plastic sheet materials against a mold.
Level I, Task 13	Air or vacuum will hold stretched thermoplastic plastic sheets against a mold while they set.	-Cooled thermoplastic sheets will maintain the shape they were held in when they became set. -Air or vacuum can be used to hold stretched thermoplastic plastic sheet materials against a mold while they become set.

APPENDIX H

LEARNING TASKS

LEARNING TASKS

Directions:

For each task, circle the word or words in the right-hand column which best complete each statement. Draw a line from the circled word or words to the blank space or spaces.

You will be informed when to complete each task.

Example Task:

Pieces of wood can be held by a ____________ ____________ while they are cut to length.

- vise
- pin
- bench
- pliers

Task Number 1:

Heating a material describes the ____________ of raising the ____________ of the material.

- height
- process
- style
- temperature

Task Number 2:

Different kinds of materials can be classified as ____________ when their ____________ is less than their width and length.

- bars
- sheets
- bands
- height
- thickness

Task Number 3:

____________ causes ____________ plastic sheets to become ____________.

- soft
- hard
- cold
- thermoplastic
- heat
- thermosetting

Task Number 4:

Thermoplastic ____________ sheets
heated to their __________ temperature
can be stretched.

wood
blistering
plastic
wood
shaping
flexible

Task Number 5:

Cooling causes ________________
plastic sheets to become ___________.

soft
set
thermowood
thermoplastic
thermometal

Task Number 6:

Force, defined as work, requires
the amount of ________________ or
_____________ to be greater than
the amount of __________________.

push
resistance
strength
pull
power

Task Number 7:

________________ or __________
can be used to exert a force.

spring
air
vacuum
bolt
punch

Task Number 8:

A ___________ serves as an
inside or outside ___________
for making an item.

tool
mold
model
item

Task Number 9:

Shape, which is produced by a mold, includes the __________, __________, __________, and __________ detail of a product.

color
width
thickness
length
surface
material

Task Number 10:

Air or ______________ can be used to exert a ______________ which will stretch sheet materials against a ____________________.

surface
tug
water
force
vacuum
mold

Task Number 11:

______________ or vacuum can be used to ______________ stretched sheet materials against a ______________.

stretch
water
surface
air
hold
mold

Task Number 12:

Air or vacuum will exert a ______________ which will stretch heated ________________ plastic sheets against a ______________.

thermowood
force
shaping
thermoplastic
bending
surface
mold

Task Number 13:

Air or vacuum will ____________ stretched thermoplastic ____________ against a ______________ while they ____________.

set
hold
mold
sheets
surface
bars
move

APPENDIX I

NV + V_C SCRIPT

NV + V_c SCRIPT

Video	Audio
Close up: Flip chart-- NV + V_c Lesson (3)*	
Medium shot: Woody (2)	Your class has been selected as a part of a research study. The study is being conducted by the United States Office of Education, the Department of Education at West Virginia University, and Kanawha County Public Schools. The purpose** of the study is to determine the best way to give a lesson to seventh and eighth grade students enrolled in industrial arts. To accomplish this purpose, your undivided attention will be required during the next three regularly scheduled industrial arts classes. Today you will be presented a lesson. Make sure you can see the TV screen. Also, make sure you have two handout sheets in front of you and a pencil or pen to write with.

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* The number refers to the camera that was used.

** The underlining identifies words or phrases that were stressed by the narrator.

	During the following two industrial arts class periods, you will be asked to complete three tests related to today's lesson. Your performance on these tests will determine the best procedure for giving lessons to other seventh and eighth grade students enrolled in industrial arts.
Zoom: Display area.	(Pause) / [*]
Medium shot: Display area.(1)	Here are some products which require the use of heat, material force, air or vacuum, and molds to make them./
Close up: Clear salad bowls.(2)	The base of this pebbled transparent salad bowl can be made from the same material as the bowl, or from wood.
Salad bowl with wood base.	The wood selected for the base can match the decorative style of the room in which it will be used.
Everett holding red bowl with plastic legs.	This bowl was made from the same type of material as the other two. The color of this bowl is bright red with white legs. By removing the legs and changing the design of the lip, this bowl can be made into a planter./

---

[*] The slanted line (/) indicates when the director switched cameras.

Close up: Everett holding planter by the brass chain.(2)	The planter is a yellow-orange color with a brass chain./
Medium shot: Woody. (1)	Today's lesson has been planned to help you develop an understanding of how heat, materials, force, air or vacuum, and molds interrelate with each other in the production of products. To help you understand these interrelationships, I have developed these two handout sheets.
Woody holds up the handout sheets.	If you will look at the handout entitled Learning Task Diagram, /
Close up: Flip chart of Learning Task Diagram.(3) Mr. X uses pointer to refer to the words heat, material, force, air or vacuum, mold, and product.	you will find the words heat, material, force, air or vacuum, mold, and product written across the bottom. Above each of these words, lines have been drawn to identify the exact meaning of the word and the new meaning of the word when it is combined with another word. Each line includes a number. The number refers to tasks to be completed by you throughout this lesson. These tasks are listed on the second handout sheet. The tasks consist of knowledge statements with key words missing. /
Close up: Flip chart-- Pieces of wood can be held by a _____ _____ while they are cut to length. vise pin bench pliers(1)	During the lesson you will be asked to complete these statements by selecting the word or words from the right-hand column which best complete the statement. /

Close up: Flip chart of Learning Task Diagram. (3) Mr. X uses pointer to refer to the words heat, material, force, air or vacuum, mold, and product.	The completion of the tasks should help you understand the interrelationships between the terms noted at the bottom of the diagram. (Pause)
Mr. X uses pointer to refer to final task.	At the top of the diagram, you will find the words, "final task." The final task consists of three tests. The first two tests will require you to interrelate tasks 12 and 13. (Pause)
Mr. X uses pointer to refer to tasks 12 and 13.	The third test will determine how well you understood tasks 1 through 13. /
Medium shot: Woody (2)	The lesson will be presented in the following manner. For each task, questions will be shown on the screen. I will read each question. / (Pause)
Close up: Flip chart-- What is a bench vise? (3)	What is a bench vise? Next, I will answer the question.
Close up: Woody (2)	After I have answered all of the questions related to a task, you will be asked to complete the task found on the learning task handout sheet. Complete the example task found on the learning task handout sheet. /
Close up: Flip chart-- Pieces of wood can be held by a _____ _______ while they are cut to length. vise pin bench pliers (3)	(Nine-second pause) /

Close up: Woody (2)	After you have completed the task, I will read the answer shown on the screen. The answer to the example, which concerned with the use of a vise to hold wood, /
Close up: Flip chart-- Pieces of wood can be held by a bench vise while they are cut to length. vise pin bench pliers(3)	is: Pieces of wood can be held by a bench vise while they are cut to length. /
Close up: Woody (2)	Please complete the tasks in the time provided. Waiting until the answers have been shown will hinder your learning. Task number 1. /
Close up: Flip chart-- Heat is? (3)	Heat is? /
Close up: Woody (2)	Heat will be defined as the process of raising the temperature of a material, object, or matter. Everett, will you come up here and place this piece of wood on the hot plate. /
Medium shot: Everett places a piece of wood on the hot plate. (1)	(Pause)
Zoom: Everett holding a piece of wood that is smoking.	The smoke you see is proof that we have raised the temperature of the wood.
Close up: Everett raises the wood from the hot plate.	Also, the wood has burned. /

Close up: Flip chart - Temperature is? (3)	Temperature is? /
Close up: Woody (2)	The process of heating a material results in raising the temperature of the material. Temperature is the degree of warmth or hotness of a material as measured by a thermometer./
Close up: Everett using a thermometer to measure the temperature of the piece of wood. (1)	The temperature of the wood was 78 degrees before Everett placed it on the hot plate. After the wood had been on the hot plate for a few seconds, the temperature of the surface of the wood touching the hot plate had increased to 200 degrees. The heating process raised the temperature of the wood 122 degrees. (Pause) Now, complete task number 1. /
Close up: Flip chart-- Heating a material describes the ____________ of raising the ____________ of the material. (3) height process style temperature	(Nine second pause) The answer to task number one, which is concerned with heating a material, /
Close up: Flip chart-- Heating a material describes the process of raising the temperature of the material. height process style temperature (2)	Heating a material describes the process of raising the temperature of the material. Task number 2. /

Close up: Flip chart-- What shapes do different materials come in? (3)	What shapes do different materials come in? /
Close up: Woody (2)	Different kinds of materials can be bought in different shapes. For example, lumber can be purchased in strips, boards, planks, and sheets./
Close up: Everett holds up each piece of metal as they are referred to. (1)	Metal can be purchased in bands, bars, (Pause) sheets, (Pause) tubes, and pipes, (Pause) just to name a few shapes. /
Close up: Flip chart-- What rule can be used to classify sheets of different kinds of materials? (3)	What rule can be used to classify sheets of different kinds of materials?/
Medium shot: Woody (2)	By recording the dimensions of different materials, we can determine which pieces of materials can be classified as sheets. A sheet is a flat piece of material. The thickness of the material is less than the width and the length. Let me demonstrate the use of this rule. /
Close up: Everett measuring the thickness, width, and length of a piece of cardboard. (1)	Here is a piece of cardboard. The cardboard is 1/32" thick (Pause) by 8"'s wide (Pause) by 10"'s long. By the use of this ruler, we could determine the dimensions, the thickness, width, and length of this piece of cardboard.

Mr. X uses pointer to point to "T", "W", and "L" columns on the flip chart.	By looking at the completed chart you can see that the thickness is less than the width and the length for each piece of material. /
Close up: Woody (2)	These materials can be classified as sheets. Complete task number 2.
Close up: Flip chart-- Different kinds of materials can be classified as ____________ when their ____________ is less than their width and length. (3) bars sheets bands height thickness	(Ten second pause)
	The answer to task two, which is concerned with the classification of sheets,
Close up: Flip chart-- Different kinds of materials can be classified as sheets when their thickness is less than their width and length. (1) bars sheets bands height thickness	is: Different kinds of materials can be classified as sheets when their thickness is less than their width and length. Task number 3. /
Close up: Flip chart-- What effect does heat have on different kinds of sheet materials? (3)	What effect does heat have on different kinds of sheet materials? /
Medium shot: Woody (2)	As a means for answering this question, let's heat the sheet materials we used in the last task to 400 degrees. /

Close up: Flip chart-- Material T x W x L Cardboard 1/32" x 8" x 10" (3)	(Pause) /
Close up: Everett measures the thickness, width, and length of a piece of brass. (1)	This piece of brass is 1/32" thick (Pause) by 4"'s wide (Pause) by 4"'s long. /
Close up: Flip chart superimposing second line on screen-- Material T x W x L Cardboard 1/32" x 8" x 10" Brass 1/32" x 4" x 4" (3)	(Pause) /
Close up: Everett measures the dimensions of a piece of aluminum. (1)	The dimensions of this piece of aluminum are 1/32 of an inch thick (Pause) by 6"'s wide (Pause) by 8"'s long. /
Close up: Flip chart superimposing third line on screen-- Material T x W x L Cardboard 1/32" x 8" x 10" Brass 1/32" x 4" x 4" Aluminum 1/32 x 6" x 8" (3)	(Pause) /
Close up: Everett measures the dimensions of a piece of plastic. (1)	Here is a sheet of plastic. It is 1/8" thick (Pause) by 3"'s wide (Pause) by 5"'s long. / (Pause)
Close up: Flip chart superimposing fourth line on screen-- Material T x W x L Cardboard 1/32" x 8" x 10" Brass 1/32" x 4" x 4" Aluminum 1/32" x 6" x 8" Plastic 1/8" x 3" x 5" (3)	(Pause)

Medium shot: Everett lights the torch. (1)	
Everett picks up the cardboard and places it over a torch.	The first sheet we will heat to 400 degrees is this piece of cardboard.
Everett places the burning cardboard in a pan of water.	(Pause)
	As you saw, the cardboard burned. Now, let's heat this brass to 400 degrees.
Everett heats a sheet of brass being held by a pair of pliers.	(Pause)
	As the temperature changed, the brass changed from a gold to a blue-brown color. Brass will become a liquid at about 1700 degrees.
Everett places the hot brass on a piece of wood.	(Pause)
	Next, let's heat this sheet of aluminum.
Everett picks up a sheet of aluminum and heats it.	(Pause)
	There was no change in the color of the aluminum sheet. When aluminum starts to become a liquid, it will turn a "whitish" color. This will take place at about 1200 degrees.
Everett places the aluminum sheets on the piece of wood provided.	(Pause)
	The sheet we have left to heat is made from plastic.

Everett picks up the thermoplastic sheet and heats it. The plastic is moved back and forth through the flame.	(Pause)
	As we raised the temperature of the sheet of plastic you will notice that it became soft. By soft, I mean the plastic remains a solid, but it has become flexible. The plastic did not melt. It did not become a liquid.
Everett picks up another pair of pliers.	
Using two pairs of pliers, he flexes the plastic sheet that has become soft.	(Pause) /
Close up: Woody (2)	From the completion of this experiment we have discovered that heat has a different effect on different kinds of sheet materials. /
Medium shot: Everett pointing to the heated sheets. (1)	At 400 degrees, the cardboard burned, the brass changed color, the aluminum remained the same color, and the sheet of plastic became soft. /
Close up: Flip chart-- What type of plastic does heat soften? (3)	What type of plastic does heat soften? /
Close up: Woody (2)	Heat softens thermoplastic plastic sheets. Just like there are different types of wood, hard or soft, there

	are different types of plastic. The two major types of plastic are thermoplastic plastics and thermosetting plastics. As a means for remembering that heat softens thermoplastic plastic sheets, divide the words thermoplastic plastic into three words--- thermo (Pause), plastic (Pause), plastics. /
Close up: Flip chart-- Thermo – plastic plastic Presence of = flexible plastic heat (3)	(Pause)
Mr. X points to the word, thermo.	The word thermo refers to the presence of heat.
Mr. X points to the word plastic.	The word plastic, used as a verb, identifies that something is flexible.
Mr. X points to the third word, plastic.	The word plastic, used as a noun, identifies the kind of material. Thus, the words thermo-plastic plastic identify that /
Close up: Woody (2)	the presence of heat will cause plastic sheets to become soft and flexible. Complete task number 3. /
Close up: Flip chart-- _________ causes _________ plastic sheets to become ______________. soft hard cold thermo-plastic heat thermo-setting (3)	(Ten second pause)

	The answer to task number three, which is concerned with the effect heat has on plastic sheets,
Close up: Flip chart-- Heat causes thermoplastic plastic sheets to become soft. soft hard cold thermoplastic heat thermosetting (1)	is: Heat causes thermoplastic plastic sheets to become soft. /
Close up: Woody (2)	Task number 4. /
Close up: Flip chart-- Can heated thermoplastic plastic sheets be stretched? (1)	Can heated thermoplastic plastic sheets be stretched? /
Close up: Woody (2)	Thermoplastic plastic sheets heated to their correct shaping temperature can be stretched. To illustrate this, we have /
Close up: Everett holds up a piece of plastic cut from a 6" square. The piece is held up in front of a 6" square piece of plastic. (1)	cut six pieces from this sheet of acrylic thermoplastic plastic. (Pause) /
Close up: Two pieces of plastic in a fry pan. (2)	These two pieces of plastic have been in this fry pan for thirty minutes. They have been heated to 160 degrees. /
Medium shot: Everett picks up one piece of plastic and flexes it. (1)	(Pause) The plastic has become soft and flexible. /

Medium shot: Woody (2)	Everett, will you please take a pair of pliers and pull on the other end of the piece of plastic? /
Medium shot: Everett takes the second piece of plastic from the fry pan. He tries to stretch the plastic by the use of two pairs of pliers. (1)	(Pause) /
Close up: Woody (2)	We can conclude that thermoplastic plastic sheets heated to their flexible temperature will become soft and flexible, but cannot be stretched. /
Medium shot: Everett standing near the laboratory oven. (1)	Two pieces of plastic have been in our oven for thirty minutes. The plastic has been heated to about 220 degrees.
Everett puts on gloves and takes one piece of plastic out of the oven.	(Pause) /
Close up: Everett flexes the plastic. (2)	As before, the plastic has become soft and flexible. Everett, will you take a pair of pliers and pull on the ends of the piece of plastic? /
Medium shot: Everett removes the second piece of plastic from the oven. Then he stretches the plastic using two pairs of pliers. (1)	(Pause)
	As you can see, the plastic did stretch. Everett, keeping the piece stretched,

	twist the plastic. Hold the plastic in the twisted position until it cools.
Everett twists the plastic and places it in a pan of water.	(Pause) /
Close up: Woody (2)	Thermoplastic plastic sheets heated to their shaping temperature will become soft and flexible, and can be stretched. /
Medium shot: Everett standing by a hot plate. (1)	The other two pieces of plastic have been heated to 300 degrees by the use of this hot plate. The plastic has become soft and flexible.
Everett, wearing gloves, picks up a piece of plastic and flexes it.	(Pause)
	It can be stretched.
Everett, using pliers, stretches the plastic.	(Pause) /
Close up: A piece of plastic lying on the hot plate. (1)	When you take a close look at the plastic, you will find it has become bubbly. The bubbles have caused the plastic to develop imperfections. /
Close up: Woody (2)	We have just demonstrated how (1) thermoplastic plastic sheets heated to /
Close up: Flip chart superimposed-- 1. Flexible temperature. (3)	their flexible temperature will become soft and flexible, but cannot be stretched; (2) thermoplastic plastics heated to their /
Close up: Flip chart superimposed-- 1. Flexible temperature. 2. Shaping temperature. (3)	shaping temperature will become soft and flexible, and can be stretched; and (3) thermoplastic plastics heated to /

Close up: Flip chart superimposed-- 1. Flexible temperature. 2. Shaping temperature. 3. Blistering temperature.(3)	their blistering temperature can be stretched, and will have formed bubbles. Complete task number 4. /
Close up: Flip chart-- Thermoplastic ________ sheets heated to their ________ temperature can be stretched. wood blistering plastic shaping flexible (2)	(Ten second pause)
	The answer to task number four, which is concerned with stretching heated thermoplastic plastic sheets, /
Close up: Flip chart-- Thermoplastic plastic sheets heated to their shaping temperature can be stretched. wood blistering plastic shaping flexible (1)	is: Thermoplastic plastic sheets heated to their shaping temperature can be stretched. Task number 5. /
Close up: Flip chart-- What happens to thermoplastic plastic sheets when they cool? (3)	What happens to thermoplastic plastic sheets when they cool?
Medium shot: Woody (2)	During the last task, I had Everett hold a stretched, twisted sheet of plastic while it cooled. Everett, will you see if you can straighten the piece of plastic? /
Close up: Everett trying to straighten the twisted plastic. (1)	(Pause)
	It doesn't work, does it? /

Close up: Flip chart-- What is the word used to describe stretched thermoplastic plastic sheets that have become cool and rigid? (3)	What is the word used to describe stretched thermoplastic plastic sheets that have become cool and rigid? /
Close up: Woody (	The word used to describe this condition is "set."
Medium shot: Everett standing next to the laboratory oven, removes a strip of plastic from the oven. (1)	This piece of plastic has been heated to its shaping temperature.
Close up: Everett ties the plastic into a bow around a piece of dowel. (2)	(Pause)
	As it cools, the plastic becomes rigid or set. By set, I mean the plastic will maintain the bow shape when it cools. Complete task number 5. /
Close up: Flip chart-- Cooling causes ____________ plastic sheets to become ____________. soft set thermo-plastic thermo-wood thermo-metal (3)	(Ten second pause)
	The answer to task number five, which is concerned with the effect cooling has on thermoplastic plastic sheets /

Close up: Flip chart--	is:
Cooling causes thermoplastic plastic sheets to become set. soft set thermo-plastic thermo-wood thermo-metal (1)	Cooling causes thermoplastic plastic sheets to become set. /
Close up: Flip chart of Learning Task Diagram. (3) Mr. X points to the numbers on the diagram when they are mentioned.	The completion of tasks one through five has resulted in identifying: (1) heating a material raises the temperature of the material, (2) different kinds of materials come in sheets, (3) heat causes thermoplastic plastic sheets to become soft and flexible, (4) thermoplastic plastic sheets heated to their shaping temperature can be stretched, and (5) thermoplastic plastic sheets that maintain the shape they were cooled in have become set. /
Close up: Woody (2)	Now we are ready to complete tasks six through twelve. These tasks are concerned with the relationships between force, air, vacuum, and molds in the production of products. Task number 6. /
Close up: Flip chart-- What is force? (3)	What is force? /

Close up: Woody (2)	Force will be defined as the amount of push or pull being greater than the amount of resistance. Sid, will you please be seated in this chair? /
Long shot - zooming to a medium shot: Everett directs Sid to be seated on a stool. (1)	(Pause) /
Medium shot: Everett and Sid (2) The word resistance is superimposed on the screen.	Sid's ability to hold his head still will represent resistance. (Pause)
The word push is superimposed on the screen. Everett pushes Sid's head to one side.	Everett's hand pressing against Sid's head will represent a push action being exerted. (Pause) Sid, you had better increase the amount of resistance the next time. You must be stronger than that! This time we are going to try to move Sid's head to one side. Are you ready, Sid?
The word pull is superimposed on the screen. Everett pulls Sid's ear causing his head to move to one side.	(Pause)
	I bet you were wondering how we were going to pull your head to one side. Thank you for your help, Sid.

Sid leaves.	(Pause)
	Complete task number 6. /
Close up: Flip chart-- Force, defined as work, requires the amount of ________ or ____________ to be greater than the amount of _______________. push resistance strength pull power (3)	(Twelve second pause)
	The answer to task number six, which is concerned with a definition of force, /
Close up: Flip chart-- Force, defined as work, requires the amount of push or pull to be greater than the amount of resistance. push resistance strength pull power (1)	is: Force, defined as work, requires the amount of push or pull to be greater than the amount of resistance. The answer is correct if you interchanged the words push and pull. /
Close up: Woody (2)	Task number 7. /
Close up: Flip chart-- What can be used to exert a force? (3)	What can be used to exert a force?/
Close up: Woody (2)	Many devices can be used to exert a force. We are primarily interested in the use of air or vacuum. /
Close up: Flip chart-- How can air be used to exert a force? (3)	How can air be used to exert a force? /
Medium shot: Everett points to the cylinder, sheet material, and syringe as they are mentioned. (1)	To illustrate how air can be used to exert a force, we will use this cylinder, this piece of sheet material, and this hypodermic syringe./

Close up: Everett holding the clamping mechanism. (2)	The clamping mechanism will serve two purposes. First, it will hold the material in place. Secondly, it will form an airtight chamber. This means no air can be removed from or pumped into the chamber without the use of the syringe.
The video tape recorder is stopped while Everett assembles the air and vacuum forming chamber.	(Stop) /
Medium shot: Woody (2)	The sheet material remains flat as long as the pressure of the air trapped inside the chamber is equal to the pressure of the air being exerted against the top of the sheet material. /
Close up: Everett holding the forming chamber. (2)	(Pause) /
	Now, we will use the syringe to pump air into the chamber. As we do this, the squeezed or compressed air will exert a force which will stretch the material.
Everett pumps air inside the chamber.	(Pause)
	As you can see, the compressed air is pushing the sheet material, the resistance, away from the base of the chamber. /
Close up: Side view of the chamber showing the stretched latex. (2)	(Pause) /

Medium shot: Everett removes the syringe and opens the valve, letting the air out of the cylinder. (1)	When the compressed air is allowed to escape from the cylinder, the sheet material returns to its original position. /
Close up: Flip chart--	
How can a vacuum be used to exert a force? (3)	How can a vacuum be used to exert a force? /
Medium shot: Everett holding the forming chamber. (2)	We will use the same cylinder. This time, instead of pushing the air into the cylinder, we will use the syringe to remove the air from the cylinder. The removal of the air will create a vacuum. A vacuum is the absence of air in an airtight chamber./
Close up: Everett creates a vacuum in the chamber by using the syringe. (1)	As the air is being removed from the cylinder, the weight of the air or atmospheris pressure is exerting a pressure on the top of the sheet material. (Pause)
Everett turns the chamber to the side to show the stretched latex.	The pulling action of the vacuum and pushing action of the atmospheric pressure caused the sheet material to be stretched into the chamber. /
Medium shot: Woody (2)	In both cases, an airtight chamber was needed to use air or vacuum to exert a force. An air leak would have resulted in no air being compressed or removed from the cylinder. Complete task number 7. /

Close up: Flip chart-- ________________ or ________________ can be used to exert a force. spring air vacuum bolt punch (3)	(Nine second pause)
	The answer to task number seven, concerned with the application of force, /
Close up: Flip chart-- Air or vacuum can be used to exert a force. spring air vacuum bolt punch (1)	is: Air or vacuum can be used to exert a force. Task number 8. /
Close up: Flip chart-- A mold is? (3)	A mold is? /
Close up: Woody (2)	A mold is an object which is similar to the item being produced from it. /
Medium shot: Everett standing next to an ice cube tray and some animal molds. (1)	Here are some examples of molds used to produce items. /
Close up: Everett holding up an ice cube tray. (2)	This mold is used to make ice cubes. the divider and the inside surface of the tray produces the shape of the cubes. /
Medium shot: Everett pointing to molds used to cast plastic objects. (1)	These molds have been used to reproduce the shape of animals.
Everett lays each animal next to the mold that each was made from.	(Pause)

	The hardened material has maintained the shape of the molds.
Everett holds up a spun disk and the wooden mold used to make the disk.	Another example of a mold is this turned piece of wood. The mold was used to make this soup bowl./
Close up: Flip chart-- How are items similar to the molds from which they were made? (3)	How are items similar to the molds from which they were made? /
Close up: Woody (2)	The best way to describe the similarity between items and the molds from which they were made is that the molds serve as a model or pattern for producing the items. /
Close up: Everett places a cast owl inside the owl mold. (1)	This mold served as a model for producing the outside shape of this owl. /
Medium shot: Everett places the soup bowl mold inside the soup bowl. (2)	This mold served as a pattern for producing the inside shape of this soup bowl. (Pause) Complete task number 8. /
Close up: Flip chart-- A ____________ serves as an inside or outside ____________ for making an item. tool mold model drawing item (3)	(Nine second pause)
	The answer to task number eight, which is concerned with the purpose of a mold, /

Close up: Flip chart-- A mold serves as an inside or outside model for making an item. tool mold model drawing item (1)	is: A mold serves as an inside or outside model for making an item.
	Task number 9. /
Close up: Flip chart-- A mold will define what of a product? (3)	A mold will define what of a product? /
Medium shot: Woody (2)	A mold defines the shape of a product. If it wasn't for this mold being the shape of a dolphin, we wouldn't be able to determine /
Close up: Everett places casted dolphin in the dolphin mold. (1)	this paperweight was in the shape of a dolphin. (Pause) /
Close up: Flip chart-- The shape of a product refers to what of the product. (3)	The shape of a product refers to what of the product? /
Close up: Woody (2)	Shape refers to the dimensions and surface detail of a product. /
Medium shot: Everett holding the painted owl and wedge-shaped paperweight. (1)	As a means for illustrating what is meant by shape, these two products have been painted black. Thus the products are similar to the shadows they would cast on a screen. From these imaginary shadows you would be unable to determine the color of the paperweights. You also would be unable to determine the material the paperweights were made from. /

Medium shot: Woody (2)	From the shadows we can determine the dimensions and surface detail, the shape, of the paperweights. /
Close up: Flip chart-- Thickness (T) = 1/2" Width (W) = 3-1/2" Length (L) = 4-1/4" (3)	The dimensions of the owl paperweight are 1/2" thick by 3-1/2"'s wide by 4-1/4"'s long. /
Medium shot: Woody (2)	Surface detail includes the smoothness or roughness and the outline of the product. /
Close up: Everett rubs the surface of the owl and wedge-shaped paperweight. (1)	The surfaces of these paperweights are smooth. The outline of this paperweight is the shape of an owl, whereas, the outline of the second can best be described as a wedge. /
Close up: Woody (2)	Shape includes the dimensions: the thickness, width, and length, and the surface detail of a product. A mold will produce the shape of a product. Complete task number 9 /
Close up: Flip chart-- Shape, which is produced by a mold, includes the ______________, ______________, ______________, and ___________ detail of a product. (3) color width thickness length surface material	(Fifteen second pause) The answer to task number nine, which is concerned with the shape of a product, /

Close up: Flip chart-- Shape, which is produced by a mold, includes the thickness, width, length and surface detail of a product. (1) color width thickness length surface material	is: Shape, which is produced by a mold, includes the thickness, width, length, and surface detail of a product. The answer is correct if you interchanged the words thickness, width, and length. Task number 10. /
Close up: Flip chart-- How can air or vacuum be used to exert a force to produce the shape of a product? (3)	How can air or vacuum be used to exert a force to produce the shape of a product? /
Medium shot: Woody (2)	The answer to this question involves identifying how air or vacuum can be used to exert a force that will stretch a piece of sheet material against a mold. /
Medium shot: Everett holding the forming chamber and mold. (1)	To demonstrate how a material can be stretched against a mold, we will use the same cylinder we used before. This time, we will place a mold in the base of the chamber. /
Close up: Everett pointing to the holes in the mold. (2)	The mold has holes through it for the purpose of removing air from the chamber. /
Medium shot: Woody (1)	The syringe will be replaced with a vacuum or air pump.
The video tape recorder is stopped while Everett re-assembles the air and vacuum forming cylinder.	(Stop) /

Medium shot: Everett hooks the vacuum hose to the base of the chamber and turns on the vacuum pump. (2)	(Pause)/
Close up: Side view of the latex stretched against the mold. (1)	(Pause)/
Medium shot: Everett unfastens the vacuum hose and opens the valve allowing air to enter the chamber. (2)	(Pause)/
Medium shot: Woody (1)	The stretched material assumed the shape of the mold as long as a vacuum was being created. This time we will use air to stretch the material against a mold. /
Medium shot: Everett moves the valve from the bottom of the chamber to the top. (2)	(Pause)
Everett, using an air hose, forces air through the air valve.	(Pause)/
Close up: Side view of the latex stretched against the mold. (1)	The air compressed in the top of the cylinder stretched the sheet material against the mold.
Everett turns off the air valve, trapping the compressed air in the chamber.	(Pause)/
Close up: Woody (2)	The stretched material reproduced the shape of the mold. As soon as the air exerted enough force to stretch the latex against the mold, the air valve was closed. Complete task number 10. /

Close up: Flip chart-- Air or __________ can be used to exert a __________ which will stretch sheet material against a __________. (3) surface tug water force vacuum mold	(Twelve second pause)
	The answer to task number ten, which is concerned with using force to produce the shape of a material,
Close up: Flip chart-- Air or vacuum can be used to exert a force which will stretch sheet material against a mold. (1) surface tug water force vacuum mold	is: Air or vacuum can be used to exert a force which will stretch sheet material against a mold.
	Task number 11. /
Close up: Flip chart-- How can air or vacuum be used to hold stretched sheet material against the mold? (3)	How can air or vacuum be used to hold stretched sheet material against a mold? /
Medium shot: Everett holding the forming chamber. (2)	You will notice the latex is still stretched against the mold. If we knew why, then we would know the answer to this question. /
Close up: Everett pointing to the valve. (1)	This valve was turned off when the air had exerted enough force to stretch the material against the mold. The closed valve trapped the compressed air in the air-tight

	chamber. The air is still exerting enough force to hold the material against the mold. The material will maintain the shape of the mold as long as the latex is held against the mold. /
Close up: Woody (2)	We will use the same cylinder to demonstrate how a vacuum can be used to hold stretched sheet material against a mold. /
Medium shot: Everett releases the air from the chamber. He moves the valve to the bottom of the chamber. (1) Then, Everett fastens the vacuum pump hose to the valve. He turns on the pump. When the vacuum draws the latex against the mold, Everett closes the valve. Then he removes the vacuum hose.	(Pause)/
Close up: Side view of the chamber. (2)	Again, you will notice the vacuum created in the chamber holds the material against the mold as long as there are no air leaks. Complete task number 11. /
Close up: Flip chart-- __________ or vacuum can be used to ________ stretched sheet materials against a __________. stretch water surface air hold mold (3)	(Twelve second pause)

	The answer to task number eleven, which is concerned with holding stretched sheet materials against a mold, /
Close up: Flip chart-- Air or vacuum can be used to hold stretched sheet materials against a mold. stretch water surface air hold mold (1)	is: Air or vacuum can be used to hold stretched sheet materials against a mold. /
Close up: Flip chart of Learning Task Diagram. (3) Mr. X points to the numbers on the diagram when they are mentioned.	We have completed tasks six through eleven. The tasks have identified that: (6) force can be defined as push or pull being greater than resistance, (7) air or vacuum can be used to exert a force, (8) a mold can be used to produce the shape of a product, (9) shape includes the thickness, width, length and surface detail of a product, (10) air or vacuum can be used to exert a force that will stretch sheet materials against a mold, and (11) air or vacuum can be used to hold stretched sheet materials against a mold.

Mr. X points to tasks 12, 4, and 10.	The completion of task number twelve will interrelate tasks four and ten. (Pause)
Mr. X points to tasks 13, 5, and 11.	Task number thirteen will interrelate tasks five and eleven. (Pause)
	Task number 12. /
Close up: Flip chart-- How can heat and force be used to stretch a sheet of thermoplastic plastic material against a mold? (2)	How can heat and force be used to stretch a sheet of thermoplastic plastic material against a mold? /
Medium shot: Woody (1)	Instead of answering this question for you, I am going to ask your assistance by having you answer silently the following series of questions.
Zoom in: Woody	Does heat have an effect on thermoplastic plastic sheets? (Pause)
	Yes.
	What kind of effect? (Pause)
	It causes them to become soft and flexible.
	Can heated thermoplastic plastic sheets be stretched? (Pause)
	Yes.
Zoom out: Woody	At what temperature? (Pause)
	At their shaping temperature.
	Can air and vacuum be used to stretch sheet materials? (Pause)
	Yes.

	Can sheet materials be stretched to produce the shape of a product? (Pause) Yes. How? (Pause) With the use of a mold.
Zoom in: Woody	The answers to these questions should enable you to understand that thermoplastic plastic sheets heated to their shaping temperature can be forced against a mold by the use of air or vacuum. The stretched sheet will reproduce the shape of a mold. /
Medium shot: Everett removes a sheet of plastic from the oven and places it on the blow former. (2)	We are removing a sheet of thermoplastic plastic from the oven. The plastic has been heated to its shaping temperature. /
Close up: Everett moves mold to one side. (1)	The dome-shaped piece is the mold. Since you will be unable to see the plastic being stretched under the mold, it will not be used. The mold will be used to complete the next task. /
Medium shot: Everett clamps the hot plastic in the blow former. (2)	(Pause) The clamps hold the plastic sheet in place and produce an air-tight chamber. /
Close up: Everett turns on the air, resulting in the plastic being stretched. (1)	(Pause)

	Compressed air under the heated plastic exerts a force which stretches the thermoplastic plastic sheet. /
Everett unfastens the air hose and opens the air valve.	(Pause)
	Releasing the air results in the plastic returning to its original shape. /
Medium shot: Woody (2)	Now, we are going to show you how a vacuum can be used to stretch thermoplastic plastic sheets against a mold. /
Medium shot: Everett places a mold on the grid of the vacuum former. (2)	A mold is placed on the grid. A vacuum will be created in the chamber below the grid.
Everett clamps a sheet of plastic in the vacuum former.	The thermoplastic plastic sheet is secured in the clamping mechanism. /
Close up: Everett lowering the heating element. (1)	The heat element is located in the top. Lowering the top turns on the element.
The video tape recorder is stopped while the plastic is being heated.	(Stop) /
Medium shot: Everett lowering the grid and turning on the vacuum cleaner. (2) The words "two minutes later" are superimposed on the screen.	(Pause)
	The plastic sheet is being drawn against the mold by the vacuum created in the metal chamber. /

Close up: The plastic being drawn against the mold. (1)	(Pause) /
Medium shot: Everett turns off the vacuum cleaner. (2)	Turning off the vacuum cleaner results in the plastic sheet not maintaining the shape of the mold. Complete task number 12. /
Close up: Flip chart-- Air or vacuum will exert a ________ that will stretch heated ________ plastic sheets against a _____. thermo- wood force shaping thermo- plastic bending surface mold (3)	(Twelve second pause)
	The answer to task number twelve, which interrelates the effect heat and force have on thermoplastic plastic sheets, /
Close up: Flip chart-- Air or vacuum will exert a force that will stretch heated thermoplastic plastic sheets against a mold. thermo- wood force shaping thermo- plastic bending surface mold (1)	is: Air or vacuum will exert a force that will stretch heated thermoplastic plastic sheets against a mold.
	Task number 13. /
Close up: Flip chart-- How do stretched thermoplastic plastic sheets maintain the shape of a mold? (3)	How do stretched thermoplastic plastic sheets maintain the shape of a mold? /

Medium shot: Woody (2)

Again, I will ask you a series of questions to be answered silently.

Does the lack of heat have an effect on thermoplastic plastic sheets? (Pause)

Yes.

What kind of effect? (Pause)

It causes them to set.

Can air and vacuum be used to hold stretched sheet materials against a mold? (Pause)

Yes.

How? (Pause)

The air or vacuum trapped in the chamber exerts a force which holds the sheet materials against a mold.

Now, we will demonstrate how air can be used to hold stretched thermoplastic plastic sheets against a mold while they set. Plastic that has become set will maintain the shape of a mold.

The video tape recorder is stopped while Everett stretches a hot sheet of plastic in the blow former. The dome-shaped mold is used.

(Stop) /

Medium shot: Everett removes the stretched plastic from the blow former. (1) The words "two minutes later" are superimposed on the screen.	Turning the air off after the plastic sheet has been stretched against the mold results in the compressed air being trapped in the air-tight chamber. (Pause)
Everett holding the formed dome-shaped plastic and mold.	As the result of the plastic becoming set, the sheet material will maintain the shape of the mold. /
Close up: Front view of the vacuum former. (2)	When a vacuum is used to hold stretched plastic sheets against a mold, closing the vacuum valve or allowing the vacuum pump to run will result in the vacuum holding the stretched material against a mold. When using this vacuum former, the heating element is turned off and the vacuum cleaner is allowed to run until the plastic has become set. Complete task number 13. /
Close up: Flip chart-- Air or vacuum will ________ stretched thermo- plastic plastic __________ against a mold while they __________.	(Twelve second pause)
set hold mold sheets surface bars moves (3)	
	The answer to task number thirteen, which is concerned with how stretched thermoplastic plastic sheets maintain the shape of a mold,

Close up: Flip chart-- Air or vacuum will hold stretched thermo- plastic plastic sheets against a mold while they set. set hold mold sheets surface bars moves (1)	is: Air or vacuum will hold stretched thermoplastic plastic sheets against a mold while they set. /
Close up: Flip chart of Learning Task Diagram. (3) Mr. X points to tasks 1 through 5 and 6 through 11.	Looking at the learning diagram, you will see that we have completed tasks one through five which were concerned with the effect the presence of or the lack of heat had on thermoplastic plastic sheets. Tasks six through eleven were concerned with the use of air or vacuum to exert a force to stretch or form sheet materials. /
Close up: Woody (2)	Forming involves the process of producing the shape of a product without adding or removing any of the material. Tasks twelve and thirteen were concerned with how the presence of or lack of heat, thermo, effects the forming of thermoplastic plastic sheets. Thermo refers to the effect which heat or the lack of heat has on a material. The following tests will require you to interrelate your understanding of tasks twelve and thirteen to answer some questions. I know you will try to do your best on these tests that will be given by your industrial arts teacher. /
Fade video. (1)	

APPENDIX J

V SCRIPT

V SCRIPT

V[illegible]	Audio
Close up: Flip chart-- V Lesson (3)*	
Medium shot: Woody (2)	Your class has been selected as a part of a research study. The study is being conducted by the United States Office of Education, the Department of Education at West Virginia University, and Kanawha County Public Schools. The purpose** of the study is to determine the best way to give a lesson to seventh and eighth grade students enrolled in industrial arts. To accomplish this purpose, your undivided attention will be required during the next three regularly scheduled industrial arts classes. Today you will be presented a lesson. Make sure you can see the TV screen. Also, make sure you have two handout sheets in front of you and a pencil or pen to write with.

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* The number refers to the camera that was used.

** The underlining identifies words or phrases that were stressed by the narrator.

	During the following two industrial arts class periods, you will be asked to complete three tests related to today's lesson. Your performance on these tests will determine the best procedure for giving lessons to other seventh and eighth grade students enrolled in industrial arts.
Zoom: Display area.	(Pause) /*
Medium shot: Display area.(1)	Here are some products which require the use of heat, material, force, air or vacuum, and molds to make them. /
Close up: Clear salad bowls. (2)	The base of this pebbled transparent salad bowl can be made from the same material as the bowl or from wood.
Salad bowl with wood base.	The wood selected for the base can match the decorative style of the room in which it will be used.
Everett holding red bowl with plastic legs.	This bowl was made from the same type of material as the other two. The color of this bowl is bright red with white legs. The lip along the top of the bowl doesn't allow the legs to rotate.

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* The slanted line (/) indicates when the director switched cameras.

	By removing the legs and changing the design of the lip, this bowl can be made into a planter. /
Close up: Everett holding planter by the brass chain. (2)	The planter is a yellow-orange color with a brass chain. /
Medium shot: Woody (1)	Today's lesson has been planned to help you develop an understanding of how heat, materials, force, air or vacuum, and molds interrelate with each other in the production of products. To help you understand these interrelationships, I have developed these two handout sheets.
Woody holds up the handout sheets.	If you will look at the handout entitled Learning Task Diagram, /
Close up: Flip chart of Learning Task Diagram. (3) Mr. X uses pointer to refer to the words heat, material, force, air or vacuum, mold and product.	you will find the words heat, material, force, air or vacuum, mold, and product written across the bottom. Above each of these words, lines have been drawn to identify the exact meaning of the word and the new meaning of the word when it is combined with the other word.
	Each line includes a number. The number refers to tasks to be completed by you throughout this lesson. These tasks are listed on the second handout sheet.
	The tasks consist of knowledge statements with key words missing. /

Close up: Flip chart-- Pieces of wood can be held by a _____ ____ while they are cut to length. — vise, pin, bench, pliers(1)	During the lesson you will be asked to complete these statements by selecting the word or words from the right-hand column which best complete the statement. /
Close up: On The, flip chart of Learning Task Diagram. (3) Mr. X uses pointer to refer to the words heat, material, force, air or vacuum, mold, and product.	The completion of the tasks should help you understand the interrelationships between the terms noted at the bottom of the diagram. (Pause)
Mr. X uses pointer to refer to final task.	At the top of the diagram, you will find the words, "final task." The final task consists of three tests. The first two tests will require you to interrelate tasks 12 and 13. (Pause)
Mr. X uses pointer to refer to tasks 12 & 13.	The third test will determine how well you understood tasks 1 through 13./
Medium shot: Woody (2)	The lesson will be presented in the following manner. For each task, questions will be shown on the screen. I will read each question./ (Pause)
Close up: Flip chart-- What is a bench vise? (3)	What is a bench vise? Next, I will answer the question.
Close up: Woody (2)	After I have answered all of the questions related to a task, you will be asked to complete the task found on the learning task handout sheet. Complete the example task found on the Learning Tasks handout sheet./

Close up: Flip chart-- Pieces of wood can be held by a _____ _____ while they are cut to length. vise pin bench pliers (3)	(Nine-second pause) /
Close up: Woody (2)	After you have completed the task, I will read the answer shown on the screen. The answer to the example, which is concerned with the use of a vise to hold wood, /
Close up: Flip chart-- Pieces of wood can be held by a bench vise while they are cut to length. vise pin bench pliers (3)	is: Pieces of wood can be held by a bench vise while they are cut to length. /
Close up: Woody (2)	**Please** complete the tasks in the time provided. Waiting until the answers have been shown will hinder your learning. Task number 1. /
Close up: Flip chart-- Heat is? (3)	Heat is? /
Close up: Woody (2)	Heat will be defined as the process of raising the temperature of a material, object, or matter. *[As a means for illustrating this process, imagine that I have placed a piece of wood 1/8" thick by 3/4" wide by 4" long on a hot plate.

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* The square brackets ([]) refer to the use of the verbal medium replacing the nonverbal medium used in the NV + V_c script.

The hot plate has a regulating device which is set for 200 degrees. As the warmth of the wood is raised, the wood will start to smoke. The surface of the wood touching the hot plate will have turned black or burned.] /

Close up: Flip chart--
Temperature is? (3)

Temperature is? /

Close up: Woody (2)

The process of heating a material results in raising the temperature of the material. Temperature is the degree of warmth or hotness of a material as measured by a thermometer.

[By the use of a thermometer, I could have measured the temperature of the piece of wood before heating it. Let us assume that the temperature of the wood was 78 degrees before I placed it on the hot plate. After the wood had been on the hot plate for a few seconds, the temperature of the surface of the wood touching the hot plate increased to 200 degrees. The heating process raised the warmth of the wood 122 degrees.] (Pause)

Now, complete task number 1. /

Close up: Flip chart--

(Nine-second pause)

Heating a material describes the
____
of raising the
____
of the material. (3)

height
process
style
temperature

	The answer to task number one, which is concerned with heating a material, /
Close up: Flip chart-- Heating a material describes the process of raising the temperature of the material. height process style temperature(2)	Heating a material describes the process of raising the temperature of the material.
	Task number 2. /
Close up: Flip chart-- What shapes do different materials come in? (3)	What shapes do different materials come in? /
Close up: Woody (2)	Different kinds of materials can be bought in different shapes. For example, lumber can be purchased in strips, boards, planks, and sheets. [Metal can be purchased in bands, bars, sheets, tubes, and pipes, just to name a few shapes. Bands are long thin strips of metal. Long pieces of metal which have square ends are classified as bars. Tubes are small diameter pieces of hollow metal. Pipes are metal tubes with larger diameters. Pipes have thicker walls than tubing.]/
Close up: Flip chart-- What rule can be used to classify sheets of different kinds of materials? (3)	What rule can be used to classify sheets of different kinds of materials? /

Medium shot: Woody (2)	By recording the dimensions of different materials, we can determine which pieces of materials can be classified as sheets. A sheet is a flat piece of material. The thickness of the material is less than the width and the length. [Suppose I had a piece of cardboard. Cardboard, like paper, is flat. The smallest dimension of the cardboard would be labelled the thickness of the material. The smallest dimension across the surface of the cardboard would be identified as its width. The length is the longest surface dimension. By the use of a ruler, I can measure the dimensions, the thickness, width, and length, of the piece of cardboard.] [The dimensions of a piece of cardboard could be 1/32" thick by 8"'s wide by 10"'s long.]
Close up: Flip chart-- Material T x W x L Cardboard 1/32" x 8" x 10" (3)	(Pause) /
Close up: Flip chart superimposing second line on screen-- Material T x W x L Cardboard 1/32" x 8" x 10" Brass 1/32" x 4" x 4"	(Pause) [The dimensions of a piece of brass could be 1/32" thick by 4"'s wide by 4"'s long.]

Close up: Flip chart superimposing third line on screen--

Material T x W x L
Cardboard 1/32" x 8" x 10"
Brass 1/32" x 4" x 4"
Aluminum 1/32" x 6" x 8" (3)

(Pause)

[The dimensions of a piece of aluminum could be 1/32" thick by 6"'s wide by 8"'s long.]

Close up: Flip chart superimposing fourth line on screen--

Material T x W x L
Cardboard 1/32" x 8" x 10"
Brass 1/32" x 4" x 4"
Aluminum 1/32" x 6" x 8"
Plastic 1/8" x 3" x 5" (3)

(Pause)

[The dimensions of a sheet of plastic would be 1/8" thick by 3"'s wide by 5"'s long.]

Mr. X uses a pointer to point to "T", "W", and "L" columns on the flip chart.

By looking at the completed chart, you can see that the thickness is less than the width and the length for each piece of material. (Pause) /

Close up: Woody (2)

These pieces of flat materials can be classified as sheets.

Complete task number 2. /

Close up: Flip chart--

Different kinds of materials can be classified as ______ when their ______ is less than their width and length. (3)

bars
sheets
bands
height
thickness

(Ten-second pause)

The answer to task two, which is concerned with the classification of sheets, /

Close up: Flip chart--

Different kinds of materials can be classified as sheets when their thickness is less than their width and length. (1)

bars
sheets
bands
height
thickness

Close up: Flip chart--

What effect does heat have on different kinds of sheet materials? (3)

Medium shot: Woody (2)

is:

Different kinds of materials can be classified as sheets when their thickness is less than their width and length.

Task number 3. /

What effect does heat have on different kinds of sheet materials? /

[As a means for answering this question, I will describe how an experiment would be conducted to determine the effect heat has on the different sheet materials we included in the last task. A small propane torch could be used to raise the temperature of the sheets to 400 degrees.]

[When we heated the piece of cardboard 1/32" thick by 8"'s wide by 10"'s long to 400 degrees we would discover that it would burn. The sheet of brass would change from a gold to a blue-brown color. It would become a liquid at around 1700 degrees.]

[The sheet of aluminum would not change color like brass would. Instead, aluminum will maintain its normal color until it has reached 1200 degrees. At this temperature, it will turn to a

	"whitish" color. Also, the aluminum will start to become a liquid.]
	[The 1/8" thick by 3"'s wide by 5"'s long piece of plastic, when heated, would become soft. By soft, I mean that the plastic remains a solid, but becomes flexible. The plastic does not melt. It does not become a liquid.] /
Close up: Woody (1)	From the completion of our experiment we will have discovered that heat has a different effect on different kinds of sheet materials. At 400 degrees, the cardboard burned, the brass changed color, the aluminum remained the same color, and the sheet of plastic became soft.
Close up: Flip chart-- What type of plastic does heat soften? (3)	What type of plastic does heat soften? /
Close up: Woody (2)	Heat softens thermoplastic plastic sheets.
	Just like there are different types of wood, hard or soft, there are different types of plastic. The two major types of plastic are thermoplastic plastics and thermosetting plastics.
	A means for remembering that heat softens thermoplastic plastic sheets is to divide the words thermoplastic plastic into three words, thermo (Pause) plastic (Pause) plastic. /

Close up: Flip chart-- Thermo - plastic plastic Presence = flexible plastic of heat (3)	(Pause)
Mr. X points to word, thermo.	The word thermo refers to the presence of heat.
Mr. X points to word, plastic.	The word plastic, used as a verb, identifies that something is flexible.
Mr. X points to third word, plastic	The word plastic, used as a noun, identifies the kind of material. Thus, the words thermo-plastic plastic identify that/
Close up: Woody (2)	the presence of heat will cause plastic sheets to become soft and flexible. Complete task number 3. /
Close up: Flip chart-- ______ causes ________ plastic sheets to become ______________. soft hard cold thermo-plastic heat thermo-setting (3)	(Ten-second pause)
	The answer to task number three, which is concerned with the effect heat has on plastic sheets, /
Close up: Flip chart-- Heat causes thermoplastic plastic sheets to become soft. soft hard cold thermo-plastic heat thermo-setting (1)	is: Heat causes thermoplastic plastic sheets to become soft. /

Close up: Woody (2)	Task number 4. /
Close up: Flip chart-- Can heated thermoplastic plastic sheets be stretched?(3)	Can heated thermoplastic plastic sheets be stretched? /
Close up: Woody (1)	Thermoplastic plastic sheets heated to their correct shaping temperature can be stretched. /
Medium shot: Woody (2)	[To illustrate this, imagine that I have cut a sheet of acrylic thermoplastic plastic into six pieces. Next, I heat three groups of two pieces each to three different temperatures.] [The first two pieces are heated to 160 degrees for thirty minutes in an electric fry pan. After picking up one piece, I will discover that the plastic has become soft and flexible.] [Next, I place each end of the second piece of plastic between the jaws of two pairs of pliers. Pulling on both ends of the heated plastic results in the plastic not stretching.] Thermoplastic plastic sheets heated to their flexible temperature will become soft and flexible, but cannot be stretched. [Two more pieces of acrylic thermoplastic plastic are heated to 220 degrees for thirty minutes in an oven. Both pieces of plastic, like before, will become soft and flexible. After pulling

on the ends of a piece of plastic, using pliers, I will discover that the plastic will stretch. Next, I stretch and twist the second piece of plastic. The plastic is held in this position until it becomes cool.]

Thermoplastic plastic sheets heated to their shaping temperature will become soft and flexible, and can be stretched.

[The last two pieces of acrylic plastic are heated to 300 degrees for thirty minutes on a hot plate. The plastic will become soft and flexible, and can be stretched. Looking closely at the surface of the pieces, I will find that the pieces have formed air bubbles. The bubbles will cause imperfections in the plastic.]

From the description of the process of heating the six pieces of acrylic plastic I have described how (1) thermoplastic plastic sheets heated to /

Close up: Flip chart superimposed-- 1. Flexible temperature. (3)	their flexible temperature will become soft and flexible but cannot be stretched; (2) thermoplastic plastic sheets heated to their /
Close up: Flip chart superimposed-- 1. Flexible temperature. 2. Shaping temperature. (3)	shaping temperature will become soft and flexible, and can be stretched; and (3) thermoplastic plastics heated to /

Close up: Flip chart superimposed-- 1. Flexible temperature. 2. Shaping temperature. 3. Blistering temperature. (3)	their blistering temperature can be stretched, and will have formed bubbles.
	Complete task number 4. / (Ten-second pause)
Close up: Flip chart-- Thermoplastic ________ sheets heated to their ________ temperature can be stretched. wood blistering plastic shaping flexible (2)	The answer to task number four, which is concerned with stretching heated thermoplastic plastic sheets, /
Close up: Flip chart-- Thermoplastic plastic sheets heated to their shaping temperature can be stretched. wood blistering plastic shaping flexible (1)	is: Thermoplastic plastic sheets heated to their shaping temperature can be stretched. Task number 5. /
Close up: Flip chart-- What happens to thermoplastic plastic sheets when they cool? (3)	What happens to thermoplastic plastic sheets when they cool? /
Medium shot: Woody (2)	[During the last task, I described stretching, twisting, and holding a piece of plastic heated to its shaping temperature until it cooled. If I tried to straighten the cooled plastic, I would find out that the plastic will have maintained the shape in which it was held while it cooled. Forcing the plastic to become flat again would result in breaking it.] /

Close up: Flip chart-- What is the word used to describe stretched thermoplastic plastic sheets that have become cool and rigid?(3)	What is the word used to describe stretched thermoplastic plastic sheets that have become cool and rigid? /
Close up: Woody (2)	The word used to describe this condition is "set." [Suppose I had heated a piece of thermoplastic 1/8" thick by 1/4" wide by 24"'s long to its shaping temperature. Next, I take the piece and wrap it once around a round piece of wood. The two ends of the plastic are tied in a knot, then a bow; just like you tie your shoes. When the plastic "string" becomes cool and rigid, it will maintain the bow shape.] Complete task number 5. /
Close up: Flip chart-- Cooling causes ____________ plastic sheets to become ____________. soft set thermoplastic thermowood thermometal(3)	(Ten-second pause) The answer to task number five, which is concerned with the effect cooling has on thermoplastic plastic sheets, /
Close up: Flip chart-- Cooling causes thermoplastic plastic sheets to become set. soft set thermoplastic thermowood thermometal(1)	is: Cooling causes thermoplastic plastic sheets to become set. /
Close up: Flip chart of Learning Task Diagram. (3)	The completion of tasks one through five has resulted in identifying:

Mr. X points to the numbers on the diagrams when they are mentioned.	(1) heating a material raises the temperature of the material, (2) different kinds of materials come in sheets, (3) heat causes thermoplastic plastic sheets to become soft and flexible, (4) thermoplastic plastic sheets heated to their shaping temperature can be stretched, and (5) thermoplastic plastic sheets that maintain the shape they were cooled in have become set. /
Close up: Woody (2)	Now we are reach to complete tasks six through twelve. These tasks are concerned with the relationships between force, air, vacuum, and molds in the production of products.
	Task number 6. /
Close up: Flip chart-- What is force? (3)	What is force? /
Close up: Woody (2)	Force will be defined as the amount of push or pull being greater than the amount of resistance.
	[As a means for illustrating force, imagine that you are sitting next to me. Your ability to hold your head still will represent resistance. My hand moving your head away from me represents force. The pushing action of my hand exerts a force which exceeds the amount of resistance, your ability to hold your head still.]

	[Now imagine that I will move your head by using a pulling action. To move your head toward me, I will pull on your ear. The pulling action exceeding the resistance results in a force being exerted.] Complete task number 6. /
Close up: Flip chart-- Force, defined as work, requires the amount of ______ or __________ to be greater than the amount of ______________. (3) push resistance strength pull power	(Twelve-second pause)
	The answer to task number six, which is concerned with a definition of force, /
Close up: Flip chart-- Force, defined as work, requires the amount of push or pull to be greater than the amount of resistance. (1) push resistance strength pull power	is: Force, defined as work, requires the amount of push or pull to be greater than the amount of resistance. The answer is correct if you interchanged the words push and pull.
	Task number 7. /
Close up: Flip chart-- What can be used to exert a force? (3)	What can be used to exert a force? /
Close up: Woody (2)	Many devices can be used to exert a force. We are primarily interested in the use of air or vacuum. /
Close up: Flip chart-- How can air be used to exert a force? (3)	How can air be used to exert a force. /

Medium shot: Woody (2)

[I will describe two experiments which will illustrate how air or vacuum can be used to exert a force. Imagine that I have a cylinder 4"'s in diameter by 5 to 6"'s high. The cylinder is made from a clear material which allows you to see what is taking place inside. The bottom of the cylinder consists of a flat circular piece. The piece is cemented to the base of the cylinder. In the middle of the base, there is a valve. The valve handle can be turned to a position to allow air to be pumped into or removed from the cylinder.]

[Fastened to the valve is a syringe. The syringe is the same shape as the hypodermic syringe a doctor may have used to give you a shot, except it is much larger. The pumping action of the syringe can be used to pump air into the cylinder or remove air from the cylinder.]

[The top of the cylinder consists of a ring with the center cut out. Bolts extending through the ring and down along the side of the cylinder hold the ring against the top. The bolts screw into bars that are located at the base of the cylinder. The top serves as a clamping mechanism for holding thin, flat pieces of material in place and producing an air-tight chamber. This means that no air can be removed from or pumped into the cylinder without the use of the syringe.]

[Now, suppose that I have secured, across the top of the cylinder, a piece of latex. The clamping ring mechanism holds the sheet material flat. Also, the closed valve at the base of the cylinder will not allow air to enter or escape from the cylinder. The latex sheet will remain flat as long as the pressure of the air trapped inside is equal to the pressure of the air being exerted against the top of the material.]

[By the use of the syringe, I can pump air into the cylinder. At the top of each stroke the valve is closed. The valve holds the air in the cylinder until the syringe is in a position to pump more air into the cylinder. The pumping action compresses or squeezes the air inside the chamber. The compressed air exerts a force which will stretch the sheet material, the resistance, through the hole of the clamping mechanism.]

[When the compressed air is allowed to escape out of the cylinder, the sheet material will return to its original position.] /

Close up: Flip chart--

How can a vacuum be used to exert a force? (3)

How can a vacuum be used to exert a force? /

Medium shot: Woody

[Using the same piece of latex and the cylinder previously described, the syringe is used to create a vacuum in the cylinder. The downward stroke of the syringe removes air from the cylinder. At the bottom of the stroke, the valve is closed and the removed air is expelled from the syringe by pushing the syringe upward. Now the syringe is in a position to remove some more air from the cylinder.]

[The removal of the air from the cylinder creates a vacuum. A vacuum is the absence of air in an air-tight chamber.]

As the air is being removed from the cylinder, the weight of the air, or atmospheric pressure, exerts a pressure on the top of the sheet material. The pulling action of the vacuum and the pushing action of the atmospheric pressure causes the sheet material to be stretched into the cylinder.]

In both cases, an air-tight chamber needed air or vacuum to exert a force. An air leak would result in the air not being compressed or being removed from the cylinder.

Complete task number 7. /

Close up: Flip chart-- ____________ spring or ____________ air can be used to vacuum exert a force. bolt punch(3)	(Nine-second pause)
	The answer to task number seven, concerned with the application of force, /
Close up: Flip chart-- Air or vacuum spring can be used to air exert a force. vacuum bolt punch (1)	is: Air or vacuum can be used to exert a force.
	Task number 8. /
Close up: Flip chart-- A mold is? (3)	A mold is? /
Close up: Woody (2)	A mold is an object which is similar to the item being produced from it. [An example of a mold is an ice cube tray. The ice cube tray divider and the inside surface of the tray produce the shape of the cubes.] [Also, molds can be used to make paperweights that are the shape of animals. The paperweights are made by pouring a liquid into a mold. The hardened material will maintain the shape of the mold.] [A third example of a mold is a circular piece of wood which is shaped like the inside of a small soup cup

		or bowl. A circular sheet of aluminum is held against the bottom of the mold on a lathe. As the sheet and wooden mold are rotated, the aluminum is pushed against the side of the mold.] /
Close up: Flip chart-- How are items similar to the molds from which they were made? (3)		How are items similar to the molds from which they were made? /
Close up: Woody (2)		The best way to describe the similarity between items and the molds from which they were made is that the molds served as a model or pattern for producing the items. [The mold used to make an owl served as a model for producing the outside shape of the owl. The wooden mold served as a pattern for producing the inside shape of the aluminum soup bowl.] Complete task number 8. /
Close up: Flip chart-- A _______ serves as an inside or outside _______ for making an item.	tool mold model drawing item (3)	(Nine-second pause) The answer to task number eight, which is concerned with the purpose of a mold, is:
Close up: Flip chart-- A mold serves as an inside or outside model for making an item.	tool mold model drawing item (1)	A mold serves an an inside or outside model for making an item.

	Task number 9. /
Close up: Flip chart-- A mold will define what of a product? (3)	A mold will define what of a product? /
Medium shot: Woody (2)	[A mold defines the shape of a product. A paperweight mold, the shape of a dolphin, will result in a paperweight being the shape of a dolphin.] /
Close up: Flip chart-- The shape of a product refers to what of the product? (3)	The shape of a produce refers to what of the product? /
Close up: Woody (2)	Shape refers to the dimensions and surface detail of a product. [Imagine that I have two paperweights. One paperweight is shaped like an owl and the second is a wedge. From the shadow cast by these two objects, you would be unable to determine the color of the paperweights. You would also be unable to determine the material from which the paperweights were made.] From the shadow we could determine the dimensions and surface detail, the shape of the paperweights. /
Close up: Flip chart-- Thickness (T) = 1/2" Width (W) = 3-1/2" Length (L) = 4-1/4" (3)	The dimensions of the owl paperweight might be 1/2" thick by 3-1/2"'s wide by 4-1/4"'s long. /

Medium shot: Woody (2)	[Surface detail includes the smoothness or roughness and the outline of a product. The surface of both paperweights is smooth. The outline of one paperweight is the shape of an owl, whereas, the outline of the second can best be described as a wedge.] /
Close up: Woody (1)	Shape includes the dimensions; the thickness, width, and length, and the surface detail of a product. A mold will produce the shape of a product. Complete task number 9. /
Close up: Flip chart-- Shape, which is produced by a mold, includes the ____________, ____________, ____________, and ____________ detail of a product. (3) color width thickness length surface material	(Fifteen-second pause) The answer to task number nine, which is concerned with the shape of a product, /
Close up: Flip chart-- Shape, which is produced by a mold, includes the thickness, width, length, and surface detail of a product. (1) color width thickness length surface material	is: Shape, which is produced by a mold, includes the thickness, width, length, and surface detail of a product. The answer is correct if you interchanged the words thickness, width, and length. Task number 10. /

Close up: Flip chart--

How can air or vacuum be used to exert a force to produce the shape of a product? (3)

How can air or vacuum be used to exert a force to produce the shape of a product? /

The answer to this question involves identifying how air or vacuum can be used to exert a force that will stretch a piece of sheet material against a mold.

[Using the same cylinder we described previously, we would place a mold inside the cylinder. The mold might consist of a circular piece of plaster of paris 2-1/2"'s thick. Recessed in the top of the plaster is the shape of a dolphin. A number of holes extend from the base of the dolphin through the plaster, meeting at the center of the base of the mold. The holes line up with the valve opening located in the base of the cylinder. The holes in the mold are used to remove air from the cylinder above the mold.]

The latex is secured to the top of the chamber by the clamping ring. The syringe is replaced with a hose fastened to a vacuum pump. When the vacuum pump is turned on, vacuum and atmospheric pressure exert a force which stretches the material against the mold. The stretched latex will assume the shape of the mold as long as the vacuum remains.]

[The use of air to stretch the latex against the mold requires fastening a cover over the hole of the clamping ring. The cover is needed to locate an air inlet above the latex.]

[The air inlet is used to allow air to exert a force against the latex. The compressed air exerts a force against the material that will stretch the latex against the mold. The cover creates an air-tight chamber between the latex and clamping mechanism.]

[The valve located at the base of the cylinder must be open so that the air located below the latex can escape when the latex is forced against the mold.]

[As soon as the air has exerted enough force to stretch the latex against the mold, the air inlet valve located in the cover is closed.]

Complete task number 10. /

Close up: Flip chart--

(Twelve-second pause)

Air or ________
can be used to
exert a ________
which will stretch
sheet material
against a ______.

surface
tug
water
force
vacuum
mold (3)

The answer to task ten, which is concerned with using force to produce the shape of a material, /

Close up: Flip chart-- Air or vacuum can be used to exert a force which will stretch sheet materials against a mold. surface tug water force vacuum mold (1)	is: Air or vacuum can be used to exert a force which will stretch sheet materials against a mold.
	Task number 11. /
Close up: Flip chart-- How can air or vacuum be used to hold stretched sheet materials against a mold? (3)	How can air or vacuum be used to hold stretched sheet materials against a mold? /
Medium shot: Woody (2)	[When we completed the last task, I mentioned that the air inlet valve was turned off as soon as the air forced the latex against the mold. If I looked at the cylinder now, I would find that the latex would still be stretched against the mold. The closed valve would have trapped the compressed air in the top of the cylinder. The air would be exerting a force that would hold the material against the mold. The material would maintain the shape of the mold as long as the latex is held against the mold.] [This same principle is involved in the use of vacuum to hold stretched materials against a mold. The vacuum created in the base of the cylinder would remain as long as the valve at the base of the chamber is closed. The closed valve will not allow any air to

	enter the chamber. The vacuum and atmospheric pressure would hold the material against the mold as long as there are no air leaks.]
	Complete task number 11. /
Close up: Flip chart--	(Twelve-second pause)
______ or vacuum can be used to ______ stretched sheet materials against a ______ . (3) stretch water surface air hold mold	The answer to task number eleven, which is concerned with holding stretched sheet materials against a mold, /
Close up: Flip chart--	is:
Air or vacuum can be used to hold stretched sheet materials against a mold. stretch water surface air hold mold (1)	Air or vacuum can be used to hold stretched sheet materials against a mold.
Close up: Flip chart of Learning Task Diagram. (3) Mr. X points to the numbers on the diagram when they are mentioned.	We have completed tasks six through eleven. The tasks have identified that: (6) force can be defined as push or pull being greater than resistance, (7) air or vacuum can be used to exert a force, (8) a mold can be used to produce the shape of a product, (9) shape includes the thickness, width, length, and surface detail of a product,

(10) air or vacuum can be used to exert a force that will stretch sheet materials against a mold, and

(11) air or vacuum can be used to hold stretched sheet materials against a mold.

The completion of task number twelve will interrelate tasks four and ten. (Pause) Task number thirteen will interrelate tasks five and eleven. (Pause)

Task number 12. /

Close up: Flip chart--
How can heat and force be used to stretch a sheet of thermoplastic plastic sheet against a mold? (1)

How can heat and force be used to stretch a sheet of thermoplastic plastic sheet against a mold? /

Medium shot: Woody (2)

Instead of answering this question for you, I am going to ask your assistance by having you answer silently the following series of questions:

Zoom in: Woody

Does heat have an effect on thermoplastic plastic sheets? (Pause)

Yes.

What kind of effect? (Pause)

It causes them to become soft and flexible.

Can heated thermoplastic plastic plastic sheets be stretched? (Pause)

Yes.

Zoom out: Woody

At what temperature? (Pause)

	At their shaping temperature.
	Can air and vacuum be used to stretch sheet materials? (Pause)
	Yes.
	Can sheet materials be stretched to produce the shape of a product? (Pause)
	Yes.
	How?
	By the use of a mold.
Zoom in: Woody	The answers to these questions should enable you to understand how thermoplastic plastic sheets heated to their shaping temperature can be forced against a mold by the use of air or vacuum. The stretched sheet will reproduce the shape of the mold. /
Medium shot: Woody (2)	[To describe this, we could use two pieces of equipment, an air former and a vacuum former. The air former consists of a flat circular aluminum base with legs. Mounted through the center of the base is a pipe. The pipe extends along the bottom of the base. At the end of the pipe, positioned along one side of the circular base, is a valve. The valve is used to control the flow of the air through the pipe.] /
Close up: Woody (1)	[Secured to the top of the circular base is a piece of rubber. The rubber is used to produce an air-tight chamber.]

[Located above and on top of the rubber seal there is a dome-shaped mold. The mold is used to produce the outside shape of a sheet of thermoplastic plastic.]

[After a sheet of plastic has been heated to its shaping temperature, it is placed on top of the rubber seal. Next, the dome-shaped mold is placed on top of the heated plastic and clamped in place by the use of a clamping ring and four C-clamps. As the air is allowed to enter the chamber, under the heated plastic, the plastic is forced against the mold. The air trapped between the top of the plastic sheet and the mold escapes through holes located in the mold.]

[When the plastic is stretched against the mold, the air valve is turned off or closed. This is done so that no excessive air pressure will break the mold.]

[After the valve is closed, it is immediately re-opened. Releasing the air from the chamber results in the heated plastic returning to its original shape.] /

Long shot: Woody (2)

[The vacuum former consists of an empty square-shaped cube made from bent sheet metal. A hose from a vacuum cleaner is attached to the back of the hollow cube. The top of the cube consists of a piece of metal with many holes. Above this metal grid is located a clamping device. This device is used to hold a plastic sheet over the top of the metal grid forming an air-tight chamber below the plastic sheet. The holes in the grid are used to remove air between the sheet of plastic and the grid.]

[Located above the square, cube-shaped metal chamber and clamping mechanism is a heating coil. The coil is used to heat the plastic after it has been placed in the clamping mechanism.] /

Close up: Woody (1)

[The first step in using the vacuum former involves positioning a mold on the metal grid. Next, a piece of thermoplastic plastic is secured in the clamping mechanism. The heating coil is turned on until the plastic has reached its shaping temperature. Turning on the vacuum cleaner causes the heated sheet to be drawn against the mold and metal grid by the vacuum created in the metal chamber.]

[Turning off the vacuum cleaner immediately after it was turned on results in the plastic sheet not conforming to the shape of the mold.]

Complete task number 12. /

Close up: Flip chart-- Air or vacuum will exert a _______ that will stretch heated _______ plastic sheets against a ________ . thermowood force shaping thermoplastic bending surface mold (3)	(Twelve-second pause)
	The answer to task number twelve, which interrelates the effect heat and force have on thermoplastic plastic sheets, /
Close up: Flip chart-- Air or vacuum will exert a force that will stretch heated thermoplastic plastic sheets against a mold. thermowood force shaping thermoplastic bending surface mold (1)	is: Air or vacuum will exert a force that will stretch heated thermoplastic plastic sheets against a mold.
	Task number 13. /
Close up: Flip chart-- How do stretched thermoplastic plastic sheets maintain the shape of a mold? (3)	How do stretched thermoplastic plastic sheets maintain the shape of a mold? /
Medium shot: Woody (2)	Again, I will ask you a series of questions to be answered silently. Does the lack of heat have an effect on soft thermoplastic plastic sheets? (Pause) Yes. What kind of effect? (Pause) It causes them to set. Can air or vacuum be used to hold stretched sheet materials against a mold? (Pause)

Yes.

How? (Pause)

The air or vacuum trapped in the chamber exerts a force which holds the sheet materials against the mold.

[Using the air or vacuum former described in the last task, we can identify how air or vacuum can be used to hold stretched plastic against a mold.]

[After the air valve of the air former was closed, the stretched plastic maintained its stretched position against the dome-shaped mold. The closed air valve trapped air inside the chamber which held the plastic sheet against the mold. The valve is kept closed until the plastic sets. As the result of the plastic becoming set, the sheet maintained the shape of the mold.]

[When a vacuum is used to hold stretched plastic sheets against a mold, closing the vacuum valve or allowing the vacuum pump to run will result in the vacuum holding the stretched material against a mold. In the case of the vacuum former previously described, the heating element is turned off after the plastic has been drawn against the mold. The vacuum cleaner is allowed to run until the plastic has become set.]

	Complete task number 13. /
Close up: Flip chart-- Air or vacuum will ________ stretched thermo- plastic plastic ________ against a mold while they ________. set hold mold sheets surface bars moves (3)	(Twelve-second pause)
	The answer to task number thirteen, which is concerned with how stretched thermoplastic plastic sheets maintain the shape of a mold, /
Close up: Flip chart-- Air or vacuum will hold stretched thermo- plastic plastic sheets against a mold while they set. set hold mold sheets surface bars moves (1)	is: Air or vacuum will hold stretched thermoplastic plastic sheets against a mold while they set. /
Close up: Flip chart of Learning Task Diagram. (3) Mr. X points to tasks 1 through 5 and 6 through 11.	Looking at the learning diagram, you will see that we have completed tasks one through five which were concerned with the effect the presence of or the lack of heat had on thermoplastic plastic sheets. Tasks six through eleven were concerned with the use of air or vacuum to exert a force to stretch or form sheet materials. /
Close up: Woody (2)	Forming involves the process of producing the shape of a product without adding or removing any of the material. Tasks twelve and thirteen were concerned with how the presence of or the lack of

heat, thermo, effects the forming of thermoplastic plastic sheets.

Thermo refers to the effect which heat or the lack of heat has on a material. The following tests will require you to interrelate your understanding of tasks twelve and thirteen to answer some questions. I know you will do your best on these tests that will be given by your industrial arts teacher. /

Fade video (1)

APPENDIX K

NV + V_s SCRIPT

NV + V_s SCRIPT

Video	Audio
Close up: Flip chart-- NV + V_s Lesson (3)*	
Medium shot: Woody (2)	Your class has been selected as part of a research study. The study is being conducted by the United States Office of Education, the Department of Education at West Virginia University, and Kanawha County Public Schools. The purpose** of the study is to determine the best way to give a lesson to seventh and eighth grade students enrolled in industrial arts. To accomplish this purpose, your undivided attention will be required during the next three regularly scheduled industrial arts classes. Today you will be presented a lesson. Make sure you can see the TV screen. Also, make sure you have the handout booklet in front of you and a pencil or pen for taking notes. During the following two industrial arts class periods, you will be asked to complete three tests related to

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* The number refers to the camera that was used.

** The underlining identifies words or phrases that were stressed by the narrator.

	today's lesson. Your performance on these tests will determine the best procedure for giving lessons to other seventh and eighth grade students enrolled in industrial arts.
Zoom: Display area	(Pause) /*
Medium shot: Display area.(1)	Here are some products which require the use of heat, material, force, air or vacuum, and molds to make them. /
Close up: Clear salad bowls. (2)	The base of this pebbled transparent salad bowl can be made from the same material as the bowl, or from wood.
Salad bowl with wood base.	The wood selected for the base can match the decorative style of the room in which it will be used.
Everett holding red bowl with plastic legs.	This bowl was made from the same type of material as the other two. The color of this bowl is bright red with white legs. By removing the legs and changing the design of the lip, this bowl can be made into a planter. /
Close up: Everett holding planter by the brass chain.(2)	The planter is a yellow-orange color with a brass chain. /

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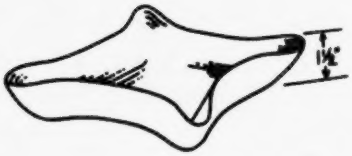
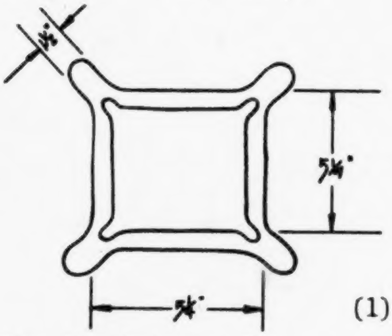
* The slanted line (/) indicates when the director switched cameras.

Medium shot: Woody (1)	Today's lesson has been planned to help you understand how to construct products which are similar to these. The first part of the lesson will be devoted to the procedure for constructing this candy dish. /
Close up: Woody pointing to the candy dish. (2)	(Pause) /
Medium shot: Woody (1)	The second part of the lesson will illustrate how the procedure used to construct the candy dish can be varied for making this napkin holder / (Pause)
Close up: Woody pointing to the napkin holder. (2)	
Close up: Woody pointing to the small bowl. (2)	and this small bowl. / (Pause) /
Medium shot: Woody (1)	The procedure for constructing the candy dish has been outlined in
Woody holds up the plan sheet.	this booklet. The booklet consists of a complete set of plans. /
Close up: Woody (2)	The four major steps that were used to develop this plan sheet have been outlined on the first page. The steps involved are: /
Close up: Flip chart--	
Making a drawing of the candy dish (3)	(1) making a drawing of the candy dish, /
Close up: Flip chart--	
Determining the procedure for constructing a wooden mold (1)	(2) determining the procedure for constructing a wooden mold, /

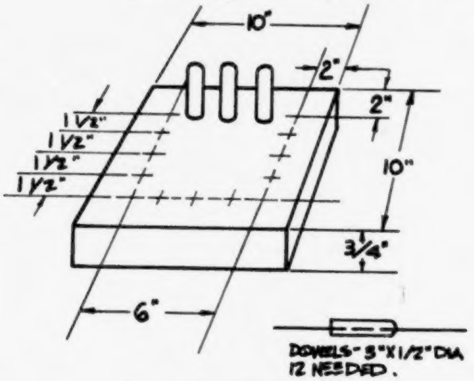
Close up: Flip chart-- Determining the procedure for making a wooden ram (3)	(3) determining the procedure for making a wooden ram, and /
Close up: Flip chart-- Determining the procedure for draping the plastic in the mold (1)	(4) determining the procedure for draping the plastic in the mold. /
Close up: Flip chart--  (3)	A drawing of the candy dish has been included on page 2 of the plan sheet. The dish is 1-1/2"'s deep. /
Mr. X points to the dimensions.	
Close up: Flip chart--  (1)	From a top view, found on page 3, we can determine that the dish is 5-1/4"'s wide by 5-1/4"'s long. The dimension across each protruding corner is 1-1/2"'s. /
Mr. X points to the dimensions.	
Close up: Everett holding the wooden mold. (2)	This is a mold (Pause) and a
Everett places the ram in the mold.	ram (Pause) which are used to produce the shape of the candy dish.

	The major categories of activities involved in the construction of the candy dish are: /
Close up: Flip chart--	
(1) Constructing the mold	(1) constructing the mold,
(2) Constructing the ram	(2) constructing the ram, and
(3) Draping the plastic (3)	(3) draping the plastic. /
Each line is superimposed on the screen as it is being said.	
Medium shot: Woody holding up the plan sheet. (2)	Each of these categories have been outlined on pages 4 and 5 of the plan sheet.
	The first step involved in the construction of the mold is to /
Close up: Flip chart-- Determine the dimensions of the mold. (3)	determine the dimensions of the mold. (Pause) /
Close up: Flip chart-- Reshow top view drawing of the candy dish. (1) Mr. X points to the dimensions.	From this drawing we can determine that the dowels must be positioned at least 5-1/4"'s apart. /
Close up: Flip chart-- Reshow pictorial of the candy dish. (3) Mr. X points to the dimensions.	The dowels must extend beyond the height of the dish. /
Close up: Woody (2)	These critical dimensions are used to /

Close up: Flip chart--
Make a drawing of the mold. (1)

make a drawing of the mold. (Pause) /

Close up: Flip chart--



(3)

Mr. X **points** to the dimensions.

The drawing determines the dimensions of the mold. The base is 3/4" thick by 10"'s wide by 10"'s long. Three 1/2" diameter dowel pins, 3"'s long, are located along each line drawn 2"'s from the edges of the base. The pins are spaced, on center, 1-1/2"'s apart. A total of 12 dowel pins are needed. /

Close up: Everett holding a piece of particle board. (1)

The base is to be made from particle board. Particle board is ground-up wood that has been glued and pressed together in the shape of a sheet of plywood. /

Close up: Woody (2)

After the selection of a piece of particle board, /

Close up: Flip chart--
Lay out dimensions of the base (10" x 10"). (3)

the dimensions of the base are laid out on it. (Pause) /

Close up: Woody (2)

The first operation done in laying out the dimensions of the base is to determine whether or not one edge of the particle board is straight. /

Medium shot: Everett holding up a piece of particle board. He places a straight edge along one edge. (1)

(Pause) /

Close up: Light showing between the blade of the square and the edge of the particle board. (2)	(Pause) /
Medium shot: Everett using the square to check the rest of the edges. (1)	(Pause) / Since all of the edges are irregular, a plane is used to smooth one edge.
Everett clamps the particle board in the bench vise. Then he planes one edge of the board.	(Pause)
Zoom: Everett marking an "X" on the planed edge.	(Pause)
Close up: Woody (2)	An "X" was placed on the planed edge so that Mr. Israel could refer to it at all times for laying out the dimensions of the base. The marked edge is referred to as the first edge. By using the framing square, the second edge is laid out 90 degrees, or square with the first edge. /
Medium shot: Everett removes the board from the vise. He places it on the bench. (1)	(Pause) /
Close up: Everett uses the framing square to draw a line. The line represents the second edge. (2)	(Pause) /
Close up: Flip chart-- Reshow pictorial drawing of the base of the mold. (3)	From the drawing of the wooden mold, we can determine the base is 10"'s wide by 10"'s long. /
Mr. X points to the dimensions.	

Close up: Woody (2)	Measuring from the line previously drawn, a second line is drawn to indicate the length of the base. /
Medium shot: Everett, using a foot rule, measures 10'''s from the second edge. (1)	(Pause) /
Close up: Everett using a framing square, draws a second line. The line represents the third edge. (2)	(Pause) /
Close up: Woody (1)	The width of the base is determined by laying out the fourth edge parallel to the first edge. /
Close up: Everett measures 10'''s from the first edge. Using the framing square, he draws a third line. The line represents the fourth edge. (2)	(Pause) Now, the base is ready to be cut to size. /
Close up: Flip chart-- Cut base to size. (3)	(Pause) /
	A jig saw is used to complete this step. /
Medium shot: Everett standing next to jig saw. (1)	
Close up: Everett adjusting the holddown guide. (2)	After the holddown guide has been adjusted for the thickness of the particle board, the base is cut to size. /
Medium shot: Everett turning on the jig saw. Then he starts to cut along one line. (1)	(Pause) /

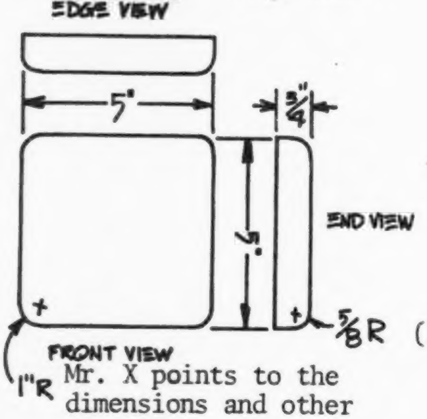
Close up: Everett cutting along one line. (2)	(Pause) /
Medium shot: Everett blowing saw dust away from the blade. (1)	(Pause) /
Close up: Everett finishing the cut along one line. (2)	(Pause) /
Medium shot: Everett turning off the jig saw. He holds the board up. (1)	(Pause) /
Zoom: Everett pointing to the edge that was cut.	The line was left to serve as a guide for smoothing the edges. /
Close up: Flip chart-- Smooth edges of base. (3)	(Pause) /
Close up: Woody (2)	To complete this step, a second base, cut to size, will be used. A plane is used to smooth each edge. /
Medium shot: Everett clamping the base in the bench vise. Then he picks up the plane. After three passes with the plane, he stops. (1)	(Pause) /
Close up: Everett holding the plane on the edge of the base. (2)	Each edge is planed to the line drawn on the base. /
Medium shot: Everett finishes planing the first edge. (1)	(Pause) /
Close up: Everett holds up a base with all four edges planed. (2)	(Pause)
	To save time, this base, with all four edges smooth, will be used to /

Close up: Flip chart-- Lay out the location of the dowel pins. (1)	lay out the location of the dowel pins. (Pause) /
Close up: Flip chart-- Reshow pictorial drawing of the base of the mold.(3)	The drawing of the mold indicates that the dowels are located along a line drawn 2"'s from each edge.
Mr. X points to the 2" lines drawn from each edge.	
Medium shot: Everett measuring 2"'s from each edge on the base. (2)	(Pause) /
Close up: Everett, using the framing square, draws four lines. (1)	(Pause) /
Close up: Everett holding the base. (2)	Now we are ready to locate the position of the dowel pins along each of these lines. /
Close up: Flip chart-- Reshow pictorial drawing of the base of the mold.(3) Mr. X points to the dimensions.	The first pin is located 1-1/2"'s from the intersection of the 2" lines. The center pin is located 1-1/2"'s from the first dowel pin, or 3"'s from the intersection. The third pin is located 4-1/2"'s from the intersection. /
Medium shot: Everett picking up a one foot rule. (2)	(Pause) /
Close up: Everett making 1-1/2", 3", and 4-1/2" marks along one 2" line.(1)	(Pause) /
Close up: Everett rotates the base 90 degrees and makes the 1-1/2", 3", and 4-1/2" marks along the second, third, and fourth 2" lines. (2)	(Pause) /

Close up: Woody (1)	Since these holes will be drilled, a center punch will be used to punch small holes at each intersection. This is done so that the drill point will be positioned on center of the holes to be drilled. /
Medium shot: Everett picking up a center punch and a mallet. (2)	(Pause) /
Close up: Everett punching centers of the holes previously located. (1)	(Pause)
	Now we are ready to drill the holes for the dowels. /
Close up: Flip chart-- Drill holes for the dowel pins. (3)	(Pause) /
Medium shot: Everett standing next to the drill press. (2)	A 1/2" twist drill is used to drill the holes.
Close up: Everett drills two holes in the base. (1)	(Pause) /
Medium shot: Everett turns off the drill. He holds up a base that has all twelve holes drilled. (2)	(Pause)
	After the twelve holes have been drilled, the dowel pins /
Close up: Flip chart-- Cut the dowel pins to length. (3)	are cut to length. (Pause) /
Close up: Woody (1)	Dowel rods are purchased in 3 ft. lengths. They come in many different diameters. The twelve 3" dowel pins are cut from 1/2" diameter dowel rods. /

Medium shot: Everett secures a dowel rod in the vise. Then he measures 3"'s from the end of the rod. (2)	(Pause) /
Close up: Everett places an "X" on the dowel previously measured. (1)	(Pause) /
Close up: Woody (2)	An "X" has been placed on this dowel pin to designate that it will be used as a pattern for determining the length of the rest of the dowel pins. /
Medium shot: Everett, using a back saw, cuts the dowel rod to length. (1)	(Pause) /
Close up: Using the marked dowel, Everett marks the next dowel to be cut to length. (2)	(Pause)
Everett cuts the second dowel to length.	(Pause)
	This operation is completed ten more times. /
Close up: Woody (1)	One end of each of the dowel pins has to be rounded so that the plastic will not be scratched during the draping process. /
Close up: Flip chart-- Round one end of each of the dowel pins. (3)	(Pause)
	A wood file and sandpaper will be used to complete this step. /
Medium shot: Everett places a dowel in the vise. (2)	(Pause) /

Close up: Everett rounds the end of the pin using a file. Then he smooths the rounded end with the piece of sandpaper. (1)	(Pause) /
Close up: Woody (2)	After this has been done to the twelve dowel pins, they are ready to be/
Close up: Flip chart-- Assemble pins in drilled holes. (3)	assembled in the drilled holes. (Pause) /
Close up: Woody (1)	If the dowel pins fit tightly, there is no need to use glue. Putting glue on tight-fitting dowel pins would result in the glue being scraped off while the pins are pounded into the drilled holes. /
Medium shot: Everett pounding the twelve dowel pins into the drilled holes. (2)	(Pause) /
Close up: Woody (1)	A line, 1-1/2"'s from the base, is drawn on the center dowel pins. This is used as a guide for determining the height of the candy dish. /
Close up: Everett placing the 1-1/2" marks on the center dowel pins. (2)	(Pause) /
Close up: Everett tilts the mold toward the camera.(1)	(Pause) Now we are ready to make the ram that will be used to drape the heated plastic in this mold. The first step involves /

Close up: Flip chart-- Making drawing of the ram. (3)	making a drawing of the ram. (Pause) /
Close up: Flip chart--  EDGE VIEW 5" 3/4" 5" END VIEW 5/8 R FRONT VIEW 1"R (1) Mr. X points to the dimensions and other details.	From this drawing we can determine that the ram is 3/4 of an inch thick by 5"'s wide by 5"'s long. The four corners and edges are rounded to allow the plastic to be draped inside the mold. The ram is made from particle board. /
Close up: Flip chart-- Lay out dimensions of the ram. (3)	(Pause) /
	The procedure that was used to lay out the dimensions of the base was used to lay out the ram. /
Medium shot: Everett resting a piece of particle board on edge. The dimensions of the ram have already been laid out. (2)	(Pause) /
Close up: Everett rotates the first edge toward the camera and points to it. The edge has an "X" marked on it. (1)	After the first edge was checked, (Pause)
Everett rotates the surface of the wood toward the camera and points to the line representing the second edge.	a line was drawn at 90 degrees, or square with the first edge.

Everett moves his finger along the first edge.	Next the length was measured and
Everett points to the third line.	a third line drawn 90 degrees with the first edge.
Everett moves his finger along the second and third lines.	Finally, the width was measured
Everett points to the fourth line.	and a fourth line drawn parallel with the first edge.
	The corners were laid out by drawing diagonals and scribing four 1" radii. /
Medium shot: Everett points to the diagonals that have been drawn on another base. (2)	(Pause) /
Close up: Everett scribes a 1" arc in one corner.	(Pause)
	Next, the ram is cut to size. /
Close up: Flip chart-- Cut ram to size. (3)	(Pause) /
Close up: Everett holding a ram cut to size. (2)	This ram was cut to size by using the jig saw. A 1" radius can be cut on the jig saw by gradually turning the wood while the blade is cutting. /
Close up: Flip chart-- Round and smooth the edges of the ram. (3)	The next step involves rounding and smoothing the edges of the ram. (Pause) /
Close up: Woody (1)	A cardboard pattern will be used to mark each edge to be rounded. /

Medium shot: Everett secures ram in the bench vise. (2)	(Pause) /
Close up: Everett, using the pattern, draws a radius on the edge of the board toward the camera. (1)	(Pause)
Everett, using the pattern, draws a radius on the edge located away from the camera.	(Pause) /
Medium shot: Everett picking up the plane. (2)	(Pause) /
Close up: Everett rounding one edge of the ram. (1)	(Pause)
Everett points to the rounded edge.	The remaining three edges are rounded in the same manner as the first edge. /
Close up: Everett picks up a ram with all four edges rounded He points to one corner. (2)	This process leaves us with pointed corners which must be rounded.
Close up: Everett secures the ram in the vise. He rounds one corner by the use of the plane. (1)	(Pause) /
Medium shot: Everett places a completed ram in a mold. (2)	Now that the mold and ram have been constructed, we are ready to drape the plastic in the mold. /
Medium shot: Woody (1)	The plastic we will be using to make the candy dish comes in sheets with paper glued to both surfaces to protect it. /
Medium shot: Everett holding a sheet of plastic with paper on both sides of it. (2)	(Pause) /

Close up: Everett removes the paper from one side of the plastic sheet. (1)	(Pause)
	The plastic can be easily scratched.
Everett uses a piece of blunt metal to scratch the plastic.	(Pause) /
	It is also brittle. Thus, it will crack and break under stress.
Medium shot: Everett holding the plastic sheet. He picks up a small piece of plastic and breaks it. (2)	(Pause) /
Close up: Woody (1)	Just as there are many different kinds of wood, there are many different kinds of plastic. /
Close up: Everett holding up a piece of plastic with the word acrylic written on the protective paper. (2)	This acrylic plastic is sometimes referred to as plexiglas. (Pause) /
Close up: Woody (1)	Also, plastic, like wood, can be classified by type. Wood can be classified as either hard or soft. Plastics can be classified by whether or not they become soft and flexible when heated. Plastics that become soft when they are heated are classified as thermoplastic plastics. Plastics that stay hard when they are heated are called thermosetting plastics. Acrylic plastic is a thermoplastic plastic.

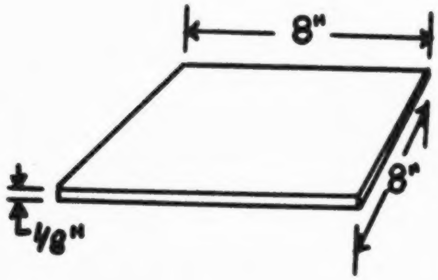
The first step in preparing the plastic to be draped is to /

Close up: Flip chart--

Determine dimensions and shape of the plastic. (3)

determine the dimensions and shape of the plastic. (Pause) /

Close up: Flip chart--



(2)

As we can see from this drawing, the acrylic plastic is to be cut into an 8" square. The plastic is 1/8" thick./

Close up: Everett holding the edges of 1/8", 1/4", and 3/8" plastic toward the camera. (1)

Plastic sheets come in many different thicknesses. The drawing requires that the plastic be 1/8" thick.

Everett points to the 1/8" thick plastic sheet.

Now we are ready to /

Close up: Flip chart--

Lay out the dimensions on the plastic sheet. (3)

lay out the dimensions on the plastic sheet. (Pause) /

Medium shot: Everett holding a piece of 1/8" plastic with an 8" square laid out on it. (2)

The procedure used to lay out the plastic for the candy dish was used to lay out the 8" square. The plastic is ready to be cut to size. /

Close up: Flip chart--

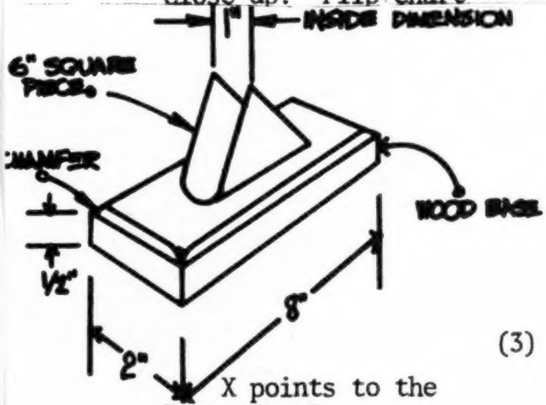
Cut plastic to size. (3)

(Pause) /

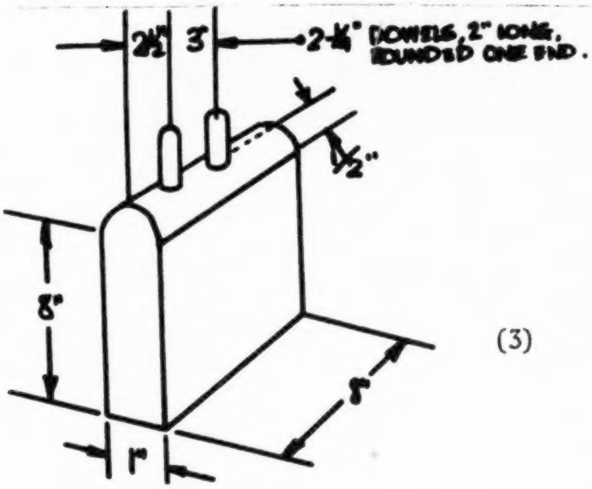
Close up: Woody (1)	A jig saw can be used to cut the plastic. When the plastic is forced against the blade, the plastic will crack. /
Medium shot: Everett standing next to the jig saw. (2)	(Pause) /
Close up: Everett turns on the jig saw.	(Pause) /
He cuts along one line. (1)	
Medium shot: Everett turns off the jig saw. He holds up a piece of plastic that has been cut to size. (2)	(Pause) /
Close up: Flip chart- Smooth edges. (3)	The next step involves smoothing the edges. (Pause) /
Close up: Woody (1)	Plastic, like wood, can be planed. The plane must be very sharp and adjusted properly or the plastic will chip. /
Medium shot: Everett secures the plastic in the vise. A single cut file, plane, sandpaper, and steel wool are located on the bench. (2)	(Pause) /
Close up: Everett planes the edge of the plastic. On each pass of the plane, he lowers the blade until it cuts. (1)	(Pause) The plane blade is adjusted after each pass until the blade cuts the edge. /
Medium shot: Everett finishes planing the edge. (2)	(Pause) /
Close up: Woody (1)	Each edge is planed to its corresponding line.

	Next, the scratch marks left by the plane are removed from each edge by the use of a single cut file, fine sandpaper, and steel wool. /
Medium shot: Everett files the planed edge.	(Pause)
Everett sands the filed edge.	The fine sandpaper will remove marks left by the file. (Pause)
Everett steel wools the sanded edge.	The steel wool will remove marks left by the sandpaper. (Pause)
Close up: Flip chart-- Remove the paper. (3)	Next, the paper is / removed from the sheet of acrylic plastic so that it won't burn when the plastic is heated to 230 degrees. (Pause) /
Close up: Woody (1)	The paper has been fastened to the plastic with rubber cement. If the rubber cement has not become dried out, the paper can be easily removed. Never remove the paper by using a sharp object. It will scratch the plastic. /
Medium shot: Everett holding a sheet of plastic. (2)	Once one side is started, the paper is folded over itself and pulled. /
Close up: Everett removing the paper from one side of the plastic sheet. (1)	(Pause)
	After the paper has been removed, /
Close up: Flip chart-- Heat plastic until soft and flexible. (3)	the plastic is heated to 200-230 degrees. (Pause) /

Medium shot: Everett starting to remove the plastic from the oven. (2)	A sheet of plastic has been in this oven for 30 minutes. The oven is set for 230 degrees. An electric fry pan or broiler can also be used to heat the acrylic plastic.
Close up: Flip chart-- Drape heated plastic in mold and hold in position until rigid. (3)	When the acrylic plastic is removed from the oven, the plastic can be / draped in the wooden mold. (Pause) /
Medium shot: Everett opening the door of the oven removes the plastic. (2)	Since the plastic is hot, gloves must be worn. (Pause)
Everett carries the heated plastic sheet to the work bench. He flexes the plastic.	As you see, the plastic has become soft and flexible. /
Close up: Everett positions the heated plastic sheet in the mold. The ram is used to hold the plastic in place. (1)	(Pause)
Zoom: Everett holding the mold, formed plastic sheet, and ram.	When placing the plastic in the mold, make sure that each edge of the dish is at the same height. This is why the 1-1/2" marks have been placed on the center dowel pins.
The video tape recorder is stopped while the plastic cools.	(STOP)
Zoom: Everett holding the mold, formed plastic sheet, and ram. The words "two minutes later," are superimposed on the screen.	(Pause) /

Medium shot: Everett removes the formed candy dish from the mold. (2)	(Pause) /
Close up: Woody (1)	If you are not satisfied with the final shape of the candy dish, the plastic can be reheated and reshaped.
Medium shot: Woody pointing to the napkin holder. (2)	The procedure that was used to make the candy dish can be varied to construct this napkin holder. /
Close up: Flip chart--  1" INSIDE DIMENSION 6" SQUARE PIECE HAMFER 1/2" WOOD BASE 8" 2" (3) X points to the bent plastic.	The dimensions of the napkin holder are shown on this drawing. The plastic section of the holder is made from a 6" square piece of acrylic plastic bent along one diagonal. /
	The two major categories of activity for constructing the napkin holder are:
Close up: Flip chart-- 1. Constructing the mold.	(1) constructing the mold, and
2. Preparing the plastic for draping. (1) Each line is superimposed on the screen as it is being said.	(2) preparing the plastic for draping./

Close up: Flip chart--



(3)

After the dimensions of the mold were determined, a drawing of the mold was made.

The mold is 1" thick by 8"'s wide by 8"'s long. One-quarter inch diameter dowel pins, 2"'s long, are used to position the plastic while it is being draped around the mold. /

After the plastic has become rigid, the holes are used to fasten the plastic to the wooden base.

Close up: Everett holding the napkin holder mold. (2)

The procedure used to construct the mold consisted of: /

Close up: Flip chart--

Selecting the particle board. (1)

(1) Selecting the particle board, /

Close up: Flip chart--

Laying out the dimensions (8" x 8"). (3)

(2) laying out the dimensions, /

Close up: Flip chart--

Cutting the mold to size. (1)

(3) cutting the mold to size, /

Close up: Flip chart--

Smoothing the edges of the mold. (3)

(4) smoothing the edges of the mold, /

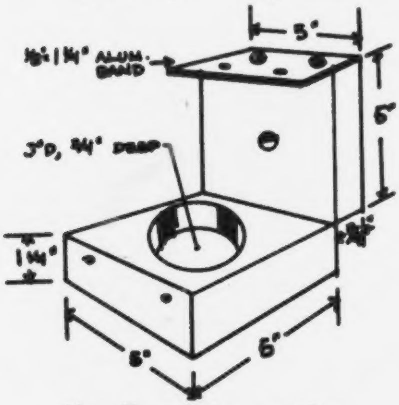
Close up: Flip chart--

Laying out the location of the dowel pin holes. (1)

(5) laying out the location of the dowel pin holes, /

Close up: Flip chart-- Drilling holes for the pins. (6)	(6) drilling holes for the pins, /
Close up: Flip chart-- Rounding the edge with the holes. (1)	(7) rounding the edge with the holes, and /
Close up: Flip chart-- Assembling the dowel pins in the drilled holes. (3)	(8) assembling the dowel pins in the drilled holes. /
Close up: Woody (2)	This procedure was developed by selecting and ordering steps that were used to construct the candy dish mold and ram. After the 1/8" acrylic plastic sheet has been: /
Medium shot: Everett holding a sheet of plastic that has been laid out. (1)	(1) laid out,
Everett holding a sheet of plastic that has been cut to size.	(2) cut to size,
Everett holding a sheet of plastic that has had all four edges smoothed.	(3) edges smoothed,
Everett holding a sheet of plastic with the holes located on it.	(4) holes located, and
Everett holding a sheet of plastic with the holes drilled.	(5) holes drilled. /
Close up: Woody (2)	The location of the holes was checked by placing the mold on the plastic. The holes drilled in the plastic are larger than the 1/4" diameter dowel pins. /

Close up: Everett holding the mold over the holes drilled in the plastic sheet. (1)	(Pause) /
Close up: Woody (2)	Next, the paper is removed and the plastic is placed in the oven for 30 minutes. The plastic is heated to 230 degrees. /
Medium shot: Everett, using gloves, drapes the plastic over the mold. (1)	(Pause) /
Close up: Everett holding the draped plastic against the mold. (2)	(Pause)
The video-tape recorder is stopped while the plastic cools.	(STOP) /
Medium shot: Everett removing the rigid plastic from the mold and placing it on a base. The words "two minutes later" are superimposed on the screen. (1)	(Pause) /
Close up: Everett holding the formed plastic on a finished base. (2)	After the draped plastic has been fastened to the finished base, the napkin holder is ready to be used. /
Close up: Bowl setting on the bench. (1)	Acrylic thermoplastic plastic sheets can also be made into small bowls, like the one shown here. /
Close up: Everett placing the bowl in the mold. (2)	The bowl was made by the use of this mold. (Pause) /

Close up: Flip chart--  1/8"x1 1/4" ALUM. BAND 5" 5" 3"D, 3/4" DEEP 3/4" 1 1/4" 5" 5" (3) Mr. X points to the dimensions.	The base of the mold is 1-1/4"'s thick by 5"'s wide by 5"'s long. Located in the center is a turned recess 3"'s in diameter by 3/4" deep. The top consists of a piece of wood 3/4" thick by 5"'s wide by 5"'s long. The top is hinged to the base. The 1/8" thick by 1-1/4"'s wide by 5"'s long strip of aluminum metal is used to latch the top to the base. /
Medium shot: Woody (1)	The procedure that was used to make the mold was developed by selecting and ordering steps shown on pages 4 and 5 of the plan sheet for constructing the candy dish. The circular recess was turned on a wood lathe. /
Close up: Everett holding a block of wood fastened to a face plate. (2)	As the wood rotates, (Pause)
Everett holding a round nose lathe tool against the block of wood.	a lathe tool was used to cut the wood. /
Close up: Reshow pictorial drawing of mold to make the small bowl. (3)	(Pause)
Mr. X points to the center hole.	The hole drilled in the center is used to force air into the chamber. /
Close up: Everett holding a piece of plastic. (2)	This piece of plastic has been (1) laid out, (2) cut to size, and (3) had the paper removed.

	The edges will be planed after the plastic has been forced into the mold. /
Close up: Woody (1)	Next the sheet of acrylic plastic was placed in a 230-degree oven for thirty minutes. /
Medium shot: Everett removing the plastic sheet from the oven. He places it in the mold. (2)	(Pause)
	The top will hold the plastic sheet in place while air forces the plastic against the turned recess.
Everett uses the air gun to form the shape of the bowl.	(Pause) /
Medium shot: Woody (1)	Too much air pressure will result in the mold breaking. The air is left on long enough to cool the plastic. After the plastic has become cool, the plastic is removed from the mold./
Medium shot: Everett removing the formed bowl from the mold. (2)	(Pause) /
Close up: Everett holding the bowl next to the mold. (1)	The rim of the bowl can be removed by using a jig saw. The edges are smoothed by filing, sanding, and steel wooling the edge. /
Medium shot: Candy dish, napkin holder, and small bowl sitting on the bench. (2)	During this lesson we identified the procedures for constructing these products. /

Close up: Candy dish. (1)	The candy dish was constructed by using the procedure that was outlined in the plan sheet.
Napkin holder.	The procedures that were used to construct the napkin holder and the small bowl were developed by varying the procedure used to construct the candy dish.
Small bowl.	The bowl was made by using air to force the heated plastic against the mold. /
Close up: Woody (2)	Other similar plastic products can be constructed by varying the procedure outlined in the plan sheet and the technique used to shape the plastic. The tests that will be given during the next two industrial arts class periods will determine how well you can apply what you have learned to different problem solving situations. Your industrial arts teacher will administer the tests. I know you will do your best. /
Fade video. (1)	

APPENDIX L

PLAN SHEET FOR CONSTRUCTING THE CANDY DISH

PLAN SHEET FOR CONSTRUCTING THE CANDY DISH

The major steps involved in planning the procedure for constructing the candy dish are:

(1) Making a drawing of the candy dish,

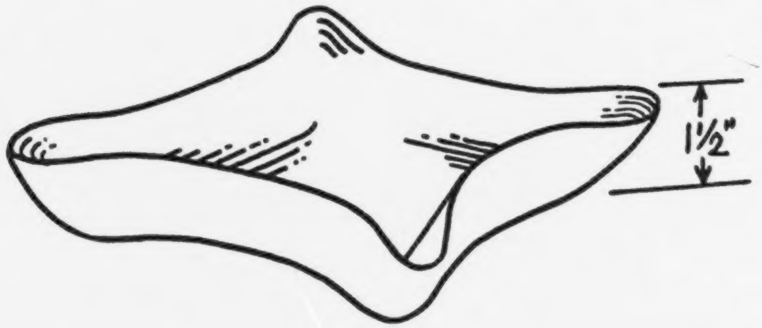
(2) determining the procedure for constructing a wooden mold,

(3) determining the procedure for constructing a wooden ram, and

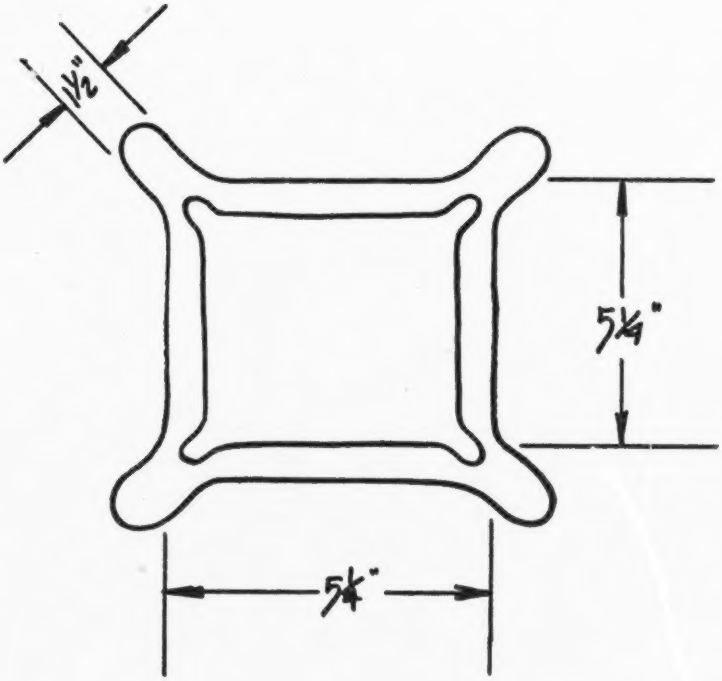
(4) determining the procedure for draping the plastic in the mold.

PLASTIC CANDY DISH

Pictorial Drawing



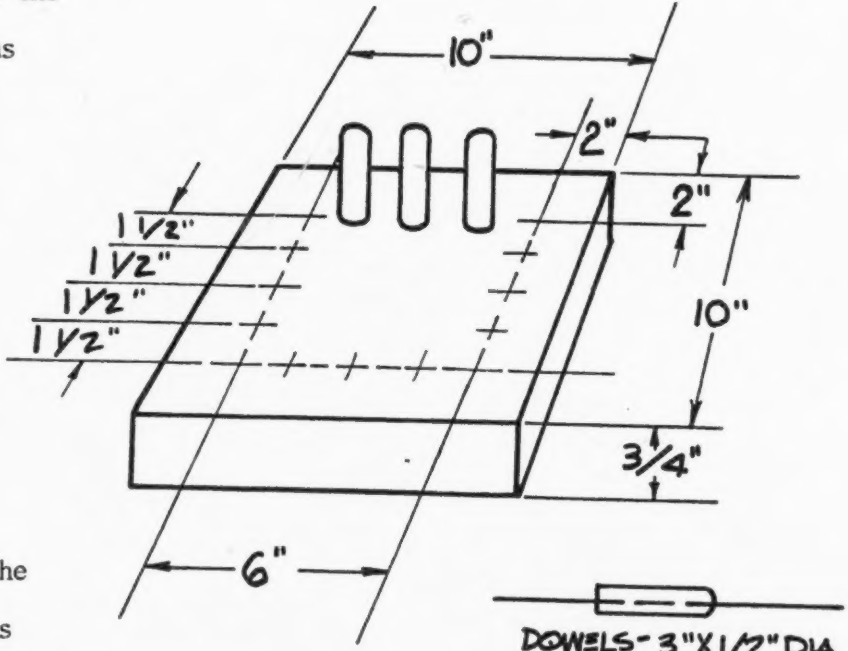
Top View



PROCEDURE FOR MAKING THE CANDY DISH

A. Construction of the wooden mold.

1. Determine the dimensions of the mold.
2. Make a drawing of the mold.
3. Lay out the dimensions of the base.

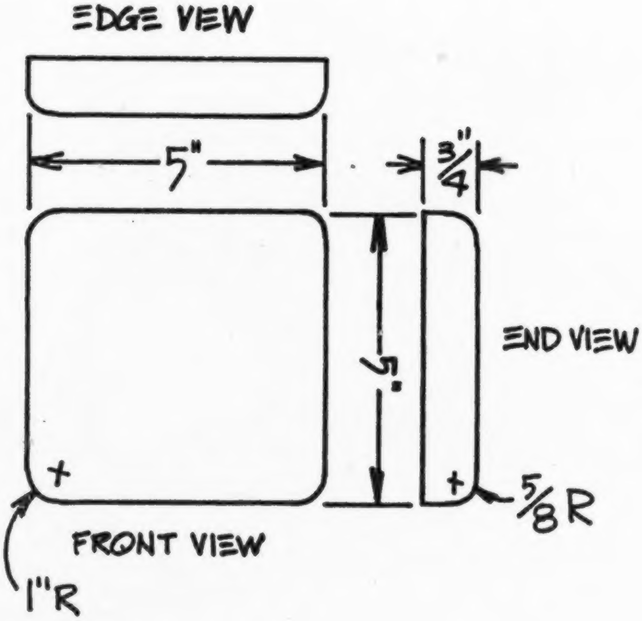


DOWELS - 3" X 1/2" DIA
12 NEEDED

4. Cut base to size.
5. Smooth edges of the base
6. Lay out the location of the dowel pins.
7. Drill holes for dowel pins.
8. Cut the dowel pins to length (3").
9. Round one end of the dowel pins.
10. Assemble pins in the drilled holes.

B. Construction of the wooden ram.

1. Make a drawing of the ram.
2. Lay out dimensions of the ram (5" x 5").
3. Cut ram to size.
4. Round and smooth edges of the ram.



C. Draping the plastic.

1. Determine the dimensions and shape of the plastic.
2. Lay out the dimensions of the plastic sheet.
3. Cut plastic to size.
4. Smooth edges.
5. Remove paper.
6. Heat plastic until soft and flexible.
7. Drape heated plastic in mold and hold in position until rigid.

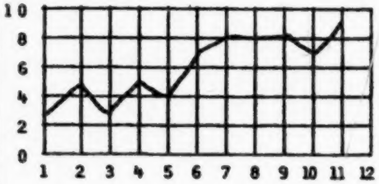
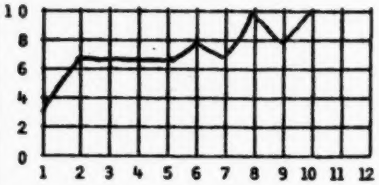
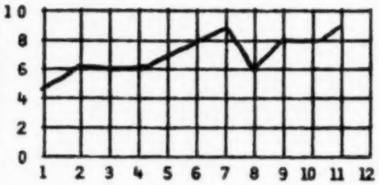
BILL OF MATERIALS

Part	Material	No. of Pieces	T	W	L
Base	Particle Board	1	3/4"	10"	10"
Dowel Pins	1/2" D Dowel Rods	12			3"
Ram	Particle Board	1	3/4"		
Dish	Plastic	1	1/8"	8"	8"

APPENDIX M

PILOT STUDY NUMBER FOUR--LEARNING ACHIEVEMENT TEST ITEMS PER SUBORDINATE TASK INCLUDING ITEM-SCORE CORRELATION, DIFFICULTY INDEXES, DISCRIMINATION INDEXES, AND ITEM DISCRIMINATION CURVES

PILOT STUDY NUMBER FOUR--LEARNING ACHIEVEMENT TEST ITEMS PER SUBORDINATE TASK INCLUDING ITEM-SCORE CORRELATION, D.I., DISC. I, AND DISC. CURVE

Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
I	(U) 1. Heat is 1. a race between two cars. 2. a process. 3. being sweaty after a race. 4. a furnace.	.36*	.61	.40	
I	(N) 2. Heat results in 1. winning a race. 2. hardening a material. 3. producing light. 4. raising the warmth of a material.	.41	.76	.42	
I	(N) 3. Evidence of heat is 1. an increase in temperature. 2. a winning car. 3. lack of snow on the ground. 4. perspiration.	.23	.71	.20	

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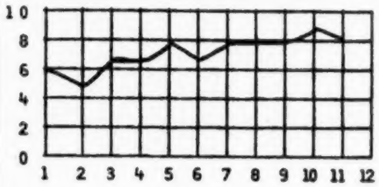
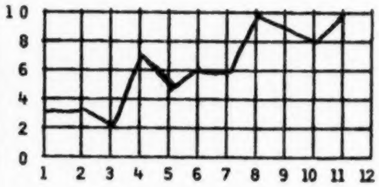
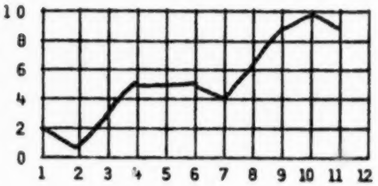
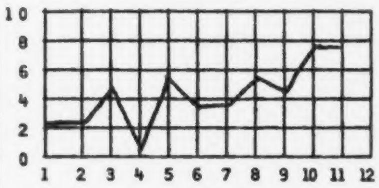
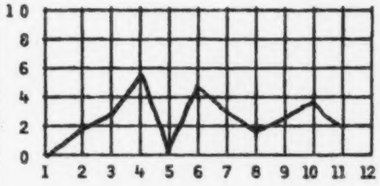
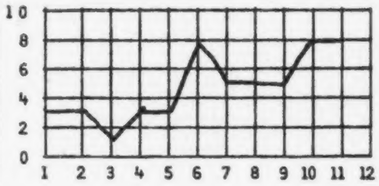
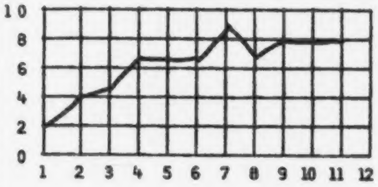
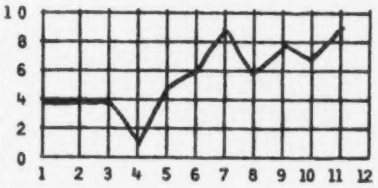
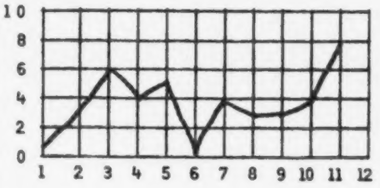
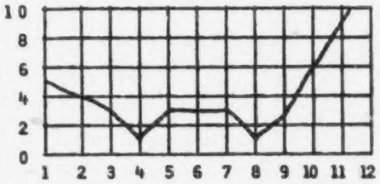
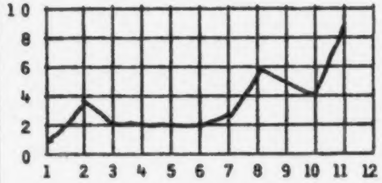
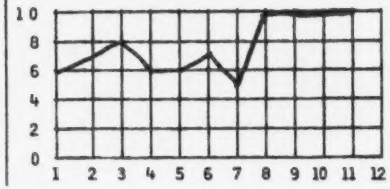
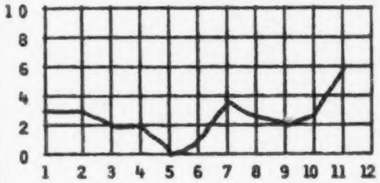
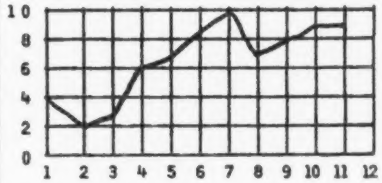
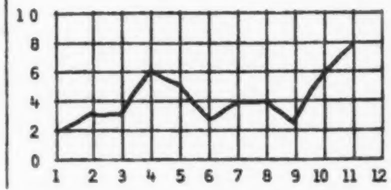
* Items with item-score correlations above .24 .

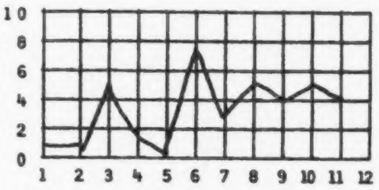
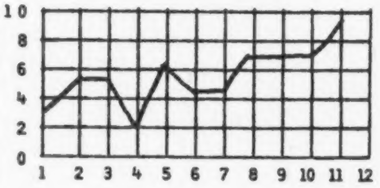
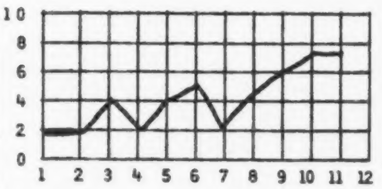
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
II	(U) 4. Masonite, metal, paper, and plywood are different types of 1. processes. 2. materials. 3. products.	.10	.74	.16	
II	(U) 5. Which of the following can be classified as a sheet? 1. a piece of metal 3/4" thick by 10" wide by 10" long 2. a piece of metal 2" thick by 2" wide by 2" long 3. a piece of metal 1" thick by 1" wide by 1" long 4. a piece of metal 6" thick by 4" wide by 12" long	.47	.63	.46	
II	(U) 6. Materials can be identified as sheets when the thickness is 1. less than the length but more than the width. 2. less than the width but more than the length. 3. more than the width or length. 4. less than the width or length.	.54	.54	.44	

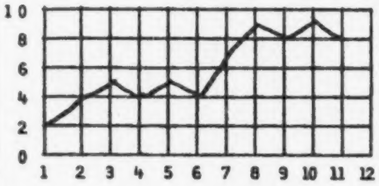
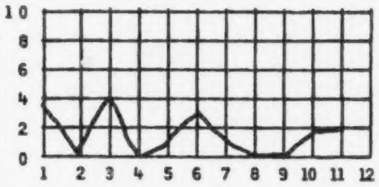
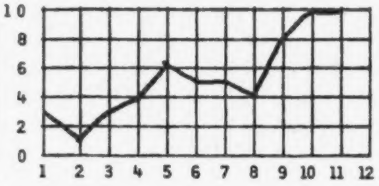
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
II	(N) 7. Which of the following are related in some manner? 1. a piece of paper, a plywood box, and a plastic pipe 2. a piece of cardboard, a magazine, and a bath towel 3. a bar of metal, a cardboard box, and a magazine 4. a plywood box, a plastic pipe, and a dish towel	.33	.48	.26	
III	(U) 8. When sheets of plastic, metal, and cardboard are heated to a low temperature (400 degrees), they will 1. become soft, become liquid, or burn. 2. burn, become soft, or change color. 3. become a liquid, remain the same, or burn. 4. burn, change color, or become a liquid.	.08	.28	.04	
III	(U) 9. Sheet materials heated to the same temperature will result in heat having 1. a different effect on different materials 2. the same effect on different materials. 3. a different effect on the same materials.	.39	.46	.36	

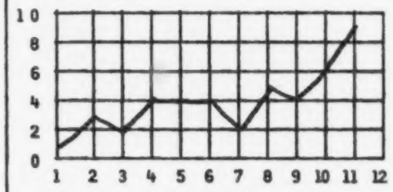
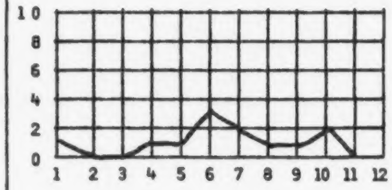
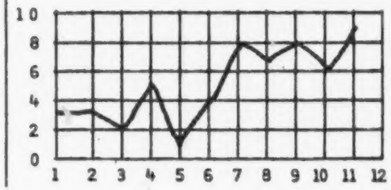
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
III	(U) 10. Low temperature (230 degrees) will cause some plastic sheets to 1. become flexible 2. become hard. 3. become a liquid. 4. become a gas. 5. cure.	.35	.65	.30	
III	(N) 11. A thermoplastic plastic will become 1. rubbery when heated. 2. hard when heated. 3. a liquid when heated. 4. cured when heated.	.40	.57	.42	
IV	(U) 12. Thermoplastic plastic sheets that have not reached their shaping temperature will become 1. bubble and blistered. 2. a liquid. 3. flexible. 4. stretchable. 5. a gas.	.25	.37	.06	

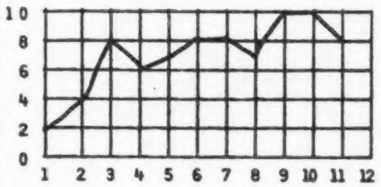
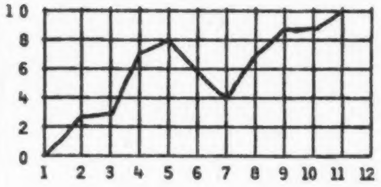
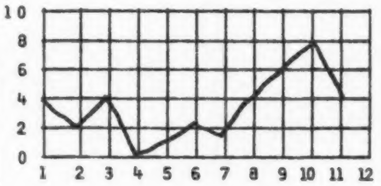
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
IV	(U) 13. Thermoplastic plastic sheets that have reached their shaping temperature will become 1. bubbly and blistered. 2. a liquid. 3. flexible. 4. stretchable. 5. a gas.	.31	.38	.14	
IV	(U) 14. Thermoplastic plastic sheets that have been heated above their shaping temperature will become 1. bubbly and blistered. 2. flexible. 3. a liquid. 4. stretchable. 5. a gas.	.37	.36	.32	
IV	(N) 15. A thermoplastic plastic sheet becomes ideal for making a product when it has reached its 1. flexible temperature. 2. shaping temperature. 3. blistering temperature.	.30	.77	.24	

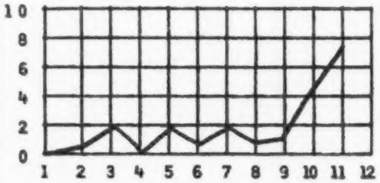
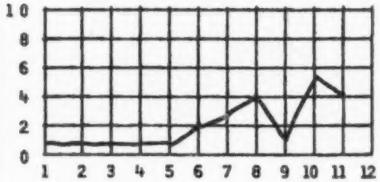
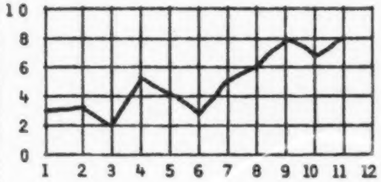
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
V	(U) 16. Heated thermoplastic plastic sheets that have "set" will 1. change from a liquid to a jelly substance. 2. take on the shape they were held at. 3. become rigid. 4. take on the shape they were held at and become rigid. 5. remain in the same place for a long period of time.	.16	.26	.16	
V	(U) 17. Heated thermoplastic plastic sheets that have "set" have become 1. warm and flexible. 2. cool and flexible. 3. warm and stretchable. 4. cool and hard. 5. warm and rigid.	.45	.67	.42	
V	(N) 18. A thermoplastic plastic sauce dish that has "set" will 1. break before it can be flatened. 2. remain in the same place for a long period of time 3. have changed from a liquid to a jelly substance. 4. be hot and rigid.	.25	.43	.16	

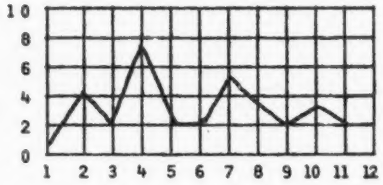
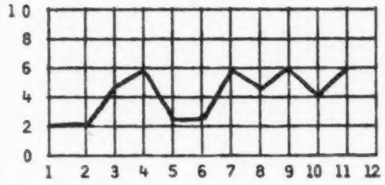
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
V	(N) 19. The lack of heat has 1. an effect on the flexibility of all plastics. 2. an effect on the flexibility of thermoplastic plastics. 3. no effect on the flexibility of thermoplastic plastics. 4. no effect on the flexibility of any plastics.	.21	.33	.26	
VI	(U) 20. Force involves a 1. push being exerted. 2. pull being exerted. 3. push or pull being exerted. 4. push or pull being exerted against a resistance.	.32	.54	.26	
VI	(U) 21. A force is exerted when the amount of 1. push is greater than the resistance. 2. push is less than the resistance. 3. pull is less than the resistance. 4. pull is equal to the resistance.	.36	.42	.34	

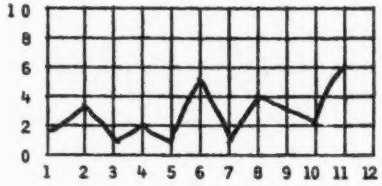
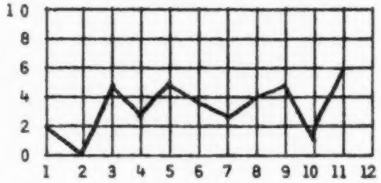
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
VI	(U) 22. An example of force is a man 1. leaning against a house. 2. pushing a lawn mower. 3. striking a concrete wall with his fist. 4. flexing his muscles.	.38	.59	.42	
VI	(N) 23. Force, defined as work, involves 1. push being less than resistance. 2. pull being greater than resistance. 3. push or pull being less than resistance. 4. push or pull being exerted against a resistance.	-.05	.15	-.06	
VII	(U) 24. An air-tight chamber is needed to apply a force by the use of 1. air or vacuum. 2. air or mechanical leverage. 3. vacuum or mechanical leverage. 4. air, vacuum, or mechanical leverage.	.49	.54	.40	

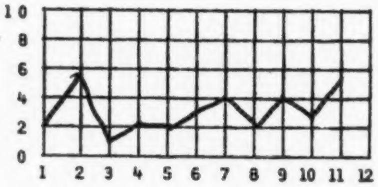
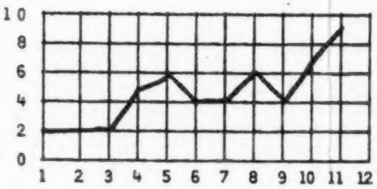
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
VII	25. The absence of air is involved in exerting a force when one uses (N) 1. compressed air. 2. a vacuum. 3. compressed air or vacuum. 4. mechanical leverage or compressed air. 5. compressed air, vacuum, or mechanical leverage.	.31	.40	.30	
VII	26. Atmospheric pressure aids in exerting a force when one uses (N) 1. compressed air. 2. a vacuum. 3. compressed air or vacuum. 4. compressed air or mechanical leverage. 5. compressed air, vacuum, or mechanical leverage.	.05	.11	.06	
VII	27. A force can be exerted when the amount of compressed air is (U) 1. equal to the resistance. 2. less than the resistance. 3. equal to or less than the resistance. 4. greater than the resistance.	.41	.51	.48	

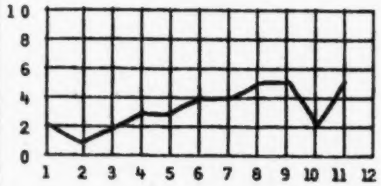
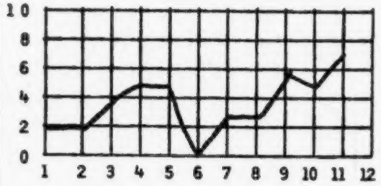
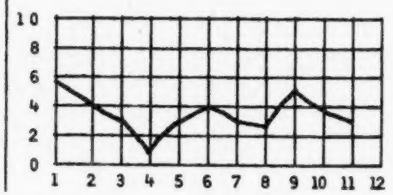
T a s k	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
VIII	(U) 28. A mold is 1. a green fungus growing on a product. 2. a model for a product. 3. marks left by an animal under the surface of a material. 4. a bump under the surface of a material.	.40	.71	.32	
VIII	(U) 29. A mold will 1. produce green fungus growing on a product. 2. produce the outside surface of a product. 3. produce the inside surface of a product. 4. produce the inside or outside surface of a product. 5. leave marks under the surface of a material.	.51	.60	.36	
VIII	(N) 30. The product created from a mold 1. must be smaller than the mold. 2. will have a surface similar to the mold. 3. will be identical with, not similar to, the mold. 4. will kill germs upon contact with them.	.30	.32	.26	

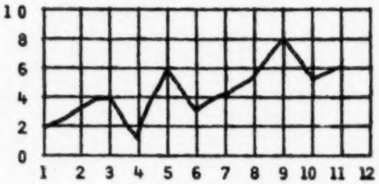
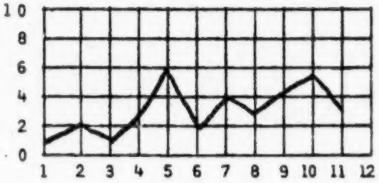
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
IX	31. The shape of a product is related to (U) 1. a shadow cast by the product. 2. the material of the product. 3. the color and the material of the product. 4. a shadow cast and the material of the product.	.41	.20	.22	
IX	32. The shape of a product includes the (U) 1. shadow cast by the product. 2. material of the product. 3. the color and the material of the product. 4. overall size and surface detail of the product. 5. overall size, material, and surface detail of the product.	.31	.22	.24	
IX	33. Which of the following describes the shape of a product? (U) 1. a white candy dish 2" high by 6" wide by 7" long 2. a glass ash tray 3/4" high by 4" wide by 6" long 3. a smooth surfaced, oval soap dish, 1/4" high by 2" wide by 6" long 4. a peanut dish 2" high by 3" wide and 6" long	.38	.48	.16	

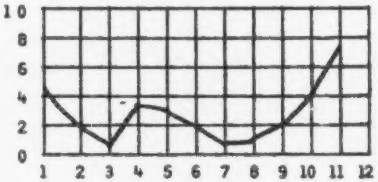
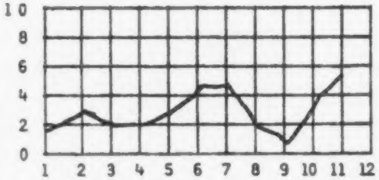
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
X	(N) 34. A balloon laid flat and clamped above a mold will conform to the shape of the mold when 1. heated with a propane torch. 2. rubbed with a felt cloth. 3. a vacuum is created above the balloon. 4. compressed air is created above the balloon. 5. compressed air is created below the balloon.	-.008	.30	-.06	
X	(N) 35. Paper clamped above a mold will 1. conform to the shape of the mold when water is poured on it. 2. take the shape of the mold when a vacuum is created. 3. tear before conforming to the shape of the mold. 4. become soft and conform to the shape of the mold when heat is applied.	.22	.44	.18	

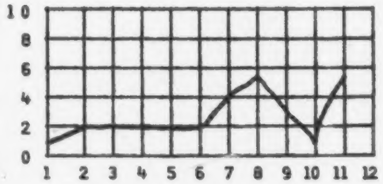
Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
X	(N) 36. What major characteristic would a piece of sheet material mounted above a mold need to reproduce the shape of the mold? 1. be thin 2. be flexible 3. be stretchable 4. be drapable 5. be hot (above 500 degrees)	.24	.27	.14	
X	(N) 37. A piece of cloth clamped above a mold would not conform to the shape of the mold because 1. the cloth is not flexible. 2. compressed air is created above the cloth. 3. the cloth has not been heated 4. an air-tight chamber has not been created.	.19	.35	.08	

Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
XI	(N) 38. A sheet material forced against a mold will maintain the shape of the mold when 1. a vacuum has been created above the sheet material. 2. air has been compressed above the sheet material 3. compressed air has been trapped above the sheet material. 4. compressed air has been trapped below the sheet material.	.12	.30	.12	
XI	(N) 39. Atmospheric pressure will hold sheet materials against a mold as long as 1. compressed air is trapped below the sheet material. 2. a vacuum is trapped above the sheet material. 3. a vacuum is trapped below the sheet material. 4. compressed air is trapped below the sheet material.	.28	.45	.24	

Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
XI	(N) 40. A sheet material that has been forced against a mold will maintain the shape of the mold as long as 1. the material is hot (500 degrees). 2. the material is soft and flexible. 3. there are not air leaks. 4. the mold stays cool.	.20	.33	.20	
XII	(U) 41. The forming of a thermoplastic plastic sheet includes 1. heating and stretching the plastic against a mold. 2. cutting, heating, and draping the plastic against a mold. 3. cutting, heating, and pouring the plastic in a mold. 4. cutting, smoothing, and assembling the plastic.	.27	.38	.12	
XII	(N) 42. A thermoplastic plastic sheet can be formed when it has been 1. cut and heated. 2. heated to its shaping temperature. 3. forced in a mold. 4. cut, heated, and forced in a mold. 5. heated to its shaping temperature and forced into a mold.	.01	.35	.04	

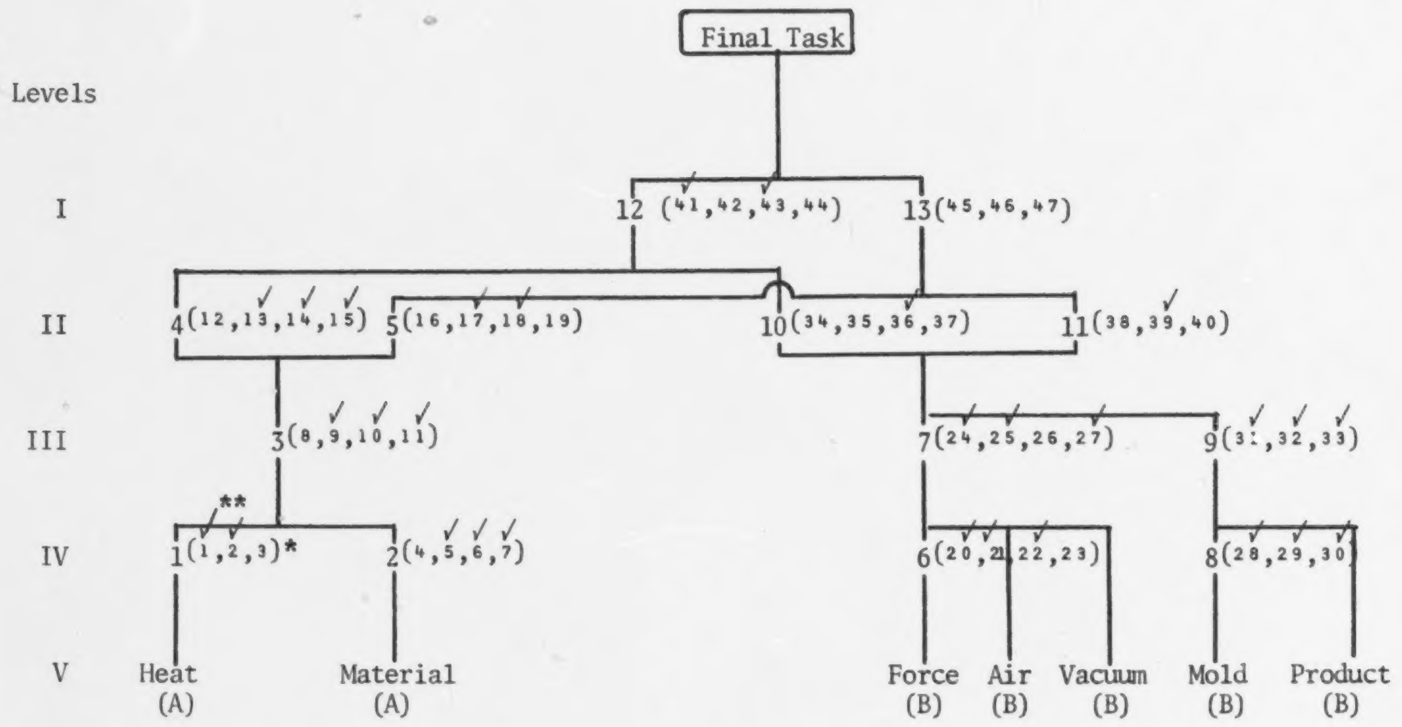
Task	Question — N = New item, U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
XII	(U) 43. An example of forming is 1. cutting, smoothing, and bending a thermoplastic plastic sheet material. 2. heating a thermoplastic plastic sheet. 3. heating a thermoplastic plastic to its shaping temperature. 4. heating and forcing a thermoplastic plastic sheet against a mold. 5. heating a thermoplastic plastic sheet to its shaping temperature and forcing it against a mold.	.28	.43	.24	
XII	(N) 44. A product is formed when 1. a human head has been carved. 2. pieces have been cut and assembled. 3. a material has been cut to a shape. 4. a piece of material has been reshaped.	.08	.31	.12	

Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
XIII	(U) 45. The process of forming a thermoplastic sheet includes 1. holding the draped plastic inside the wooden mold until it has set. 2. allowing the poured plastic to remain in the mold until it has set. 3. holding the bent plastic against the mold until it has set. 4. holding the stretched plastic against the mold until it has set.	.15	.28	.02	
XIII	(N) 46. A heated thermoplastic plastic sheet is held against a mold while it sets to insure the 1. draped plastic will maintain the shape of the mold. 2. bent plastic will maintain the shape of the mold. 3. stretched plastic will maintain the shape of the mold. 4. mold has cooled.	.21	.32	.12	

Task	Question N = New item U = Item used before	Item to Score Corr.	D.I.	Disc. I	Item Disc. Curve
XIII	47. A heated thermoplastic plastic sheet will maintain the shape of a mold as long as (N) 1. the plastic is hot. 2. the plastic is soft and flexible. 3. there are not air leaks. 4. the mold stays cool.	.14	.26	.18	

I-A

Learning Task Diagram


Final Task
Levels
I
II
III
IV
V
12 (41,42,43,44)
13(45,46,47)
4(12,13,14,15)
5(16,17,18,19)
10(34,35,36,37)
11(38,39,40)
3(8,9,10,11)
7(24,25,26,27)
9(31,32,33)
**
1(1,2,3)*
2(4,5,6,7)
6(20,21,22,23)
8(28,29,30)
Heat (A)
Material (A)
Force (B)
Air (B)
Vacuum (B)
Mold (B)
Product (B)

* Test item numbers per task

** Items with item-score correlation above .24

APPENDIX N

DESCRIPTION OF RESPONDENTS INVOLVED IN THE STUDY

DESCRIPTION OF RESPONDENTS INVOLVED IN THE STUDY

Number Assigned to School and Response	Number Assigned to Industrial Arts Teachers and Response	Rotation System	Treatment	Number of Classes	Number of Students	Classes Randomly Assigned	Number of Students Per Class
1 Yes	1 No	12 + 18 week	PVL	7-8th	125	2pd,8th	8
	2 Yes					4pd,8th	16
						7pd,7th	7
							31
2 Yes	3 Yes	18 week	PVL	7th	63	7th	20
		Modular System		8th	71	8th	27
					134		47
	4 Yes	Open Classroom School	PVL			All randomly selected	(5 classes)
		Team Teaching					
3 Yes	5 Yes	12 week	$NV + V_c$	5-7th	74	2pd,7th	11
				5-8th	72	6pd,8th	14
					146		25
4 Yes	6 Yes	18 week	V	8-8th	126	1pd,8th	16
				4-8th		2pd,8th	19
	7 Yes	18 week	V	8-7th	94	4pd,7th	13
					220	5pd,7th	10
						7pd,7th	12
							70

5	Yes	8	Yes	18 week	V	5-8th	93	2pd,8th	22
								5pd,8th	11
									33
6	Yes	9	Yes	9 week	NV + V_s	12-7th	132	1pd,8th	12
						12-8th	146	2pd,8th	12
							278	4pd,7th	11
								3pd,7th	11
								4pd,7th	10
									56
7	No	11							
8	Yes	12	Yes	12 week	NV + V_c	8-8th	145	3pd,8th	18
								4pd,8th	18
		13	Yes	12 week	NV + V_c	9-7th	182	1pd,7th	23
							327	2pd,7th	13
									72
9	No	14							
		15							
10	Yes	16	Yes	18 week	PVL	11-8th	220	3pd,8th	19
								4pd,8th	19
								7pd,8th	18
		17	Yes	18 week	PVL			2pd,8th	21
								7pd,8th	20
									97

11	No	18							
		19							
		20							
12	Yes	21	Yes	12 week	NV + V_c	5-7th 5-8th	97 78 175	1pd,8th 3pd,7th 4pd,8th	13 17 17 47
13	Yes	22	Yes	12 week	NV + V_s	6-7th 6-8th	57 58 105	3pd,7th 4pd,8th	10 12 22
14	Yes	23	Yes	12 week	NV + V_s	6-7th 6-8th	83 79 162	Section 8,1 Section 8,4 Section 7,1 Section 7,4	13 12 13 13 51
15	Yes	24	Yes	18 week	NV + V_s	5-8th	70	Section 8,2 Section 8,3 Section 8,4 Section 8,5	11 10 19 17
		25	Yes	18 week	NV + V_s	5-7th	73 143	Section 7,3	15 72

16	Yes	26	Yes	12 week	V	2-8th	30	4pd,8th	15
									15
17	Yes	27	Yes	9 week	PVL	8-7th	123	1pd,7th	18
						8-8th	113	2pd,7th	15
							236	4pd,8th	17
									50
18	No	28							
19	Yes	29	Yes	18 week	NV + V_c	8-7th	126	1+2pd,T+Th,8th	16
								1+2pd,M,W,F,8th	20
								5+6pd,M,W,F,8th	21
		30	Yes	18 week	NV + V_c	8-8th	159	1+2pd,T+Th,7th	13
							285	3+4pd,M,W,F,7th	14
									84
20	Yes	31	Yes	18 week	V	6-8th	98	1pd,8th	15
								3pd,8th	15
									30
		32	No						
21	Yes	33	Yes	9 week	NV + V_c	3-7th	37	2pd,7th	19
						3-8th	38	4pd,8th	13
							75		32

22	Yes	34	Yes	9 week	V	8-7th 9-8th	129 131 260	3pd,8th 4pd,7th	14 17
		35	Yes	9 week	V			4pd,7th 8pd,7th	16 16
		36	Yes	9 week	V			2pd,8th 3pd,8th 8pd,7th	15 16 14
									108
					Totals		2,852		920*

Summary:

18 out of 22 Principals granted permission	Principals' approval identified a potential of 29 out of 36 teachers	A total of 27 out of 29 teachers volunteered to participate in the study	Total number of schools assigned to each treatment		Total number of classes randomly selected per treatment	
			$NV + V_c$	5	$NV + V_c$	16
			V	5	V	16
			$NV + V_s$	4	$NV + V_s$	16
			PVL	4	PVL	16
				18		64

---

* Total includes 4 classes of faulty data and students who were absent.

APPENDIX O

PROGRAMMED INSTRUCTIONS

(Instructional Booklet)

II

PROGRAMMED INSTRUCTIONS
(INSTRUCTIONAL BOOKLET)

This booklet describes the directions for taking a programmed decision-making test. Each page of the decision-making test will be divided into sections. Each section will include a question. The question will be a statement of a problem to be solved. The choices listed under each question represent different possible solutions. Your task will be to select choices to questions that will best accomplish a specific goal.

This programmed instruction booklet includes an example of a decision-making test. The example test is concerned with baseball. Your goal is to make decisions that will result in your making a run.

The first question is:

A. The bat you selected was

1. 28" long (question C, page 4).
2. 30" long (question D, page 4).
3. 32" long (question E, page 4).

Select a choice --- either 1, 2, or 3.

Your selected choice --- 1, 2, or 3 --- will be recorded on the answer sheet provided. Under the words, "Question A, Page 1", you will find the word, "Choice". The blank space next to the word "Choice" is for you to record your selection. Below is an example of where you will find the blank space to record your choice on the answer sheet.

Example:

Column I

Question A, Page 1

Choice ___ [This space has been provided for you to record your answer.]

Now record the number of your choice --- 1, 2, or 3 --- on the answer sheet.

As the result of selecting choice 1, 2, or 3, you have determined the next question to be answered. The next question to be answered is identified in parentheses following each choice.

A. The bat you selected was

1. 28" long (question C, page 4).
2. 30" long (question D, page 4).
3. 32" long (question E, page 4).

If you selected choice 1, the next question to be answered is C found on page 4. If you selected choice 2, the next question to be answered is D found on page 4. If you selected choice 3, the next question to be answered is E found on page 4.

The next question to be answered is recorded on your answer sheet. You will find the words "Question ___, Page ___" under the choice you recorded on the answer sheet. The blank spaces have been provided for you to record the letter and page number of the next question to be answered. The recording of the next question to be answered will allow you to turn pages in the test booklet without losing your place.

Now, record the letter and page number of the next question to be answered on your answer sheet.

If you selected choice 1, your answer sheet should look like this:

Column I

Question A, Page 1

Choice 1

Question C, Page 4

If you selected choice 2, your answer sheet should look like this:

Column I

Question A, Page 1

Choice 2

Question D, Page 4

If you selected choice 3, your answer sheet should look like this:

Column I

Question A, Page 1

Choice 3

Question E, Page 4

Now you are ready to go to page 4 and answer the next question. Before doing this, listen very carefully to these directions. After you have recorded your choice for the question you answered on page 4, you will be directed to go to another page to answer another question. Then you will be directed to page 8. When you turn to page 8, wait until the tape recorder is started.

B. Dogs have

1. paws.
2. tails.
3. toe nails.

STOP! If you are answering this question, you did not follow directions. Choice 1, 2, or 3 for Question A directed you to question C, D, or E on page 4, but not to question B.

A. The bat you selected was

1. 28" long (Question C, Page 4).
2. 30" long (Question D, Page 4).
3. 32" long (Question E, Page 4).

C. The 28" bat was made from

1. ash (Question F, Page 5).
2. oak (Question G, Page 5).

Now record your choice on the answer sheet. Also record the letter and page number of the next question to be answered. Then go to F or G on page 5.

D. The 30" bat had

1. tape on the handle (Question H, Page 6).
2. a rubberized handle (Question I, Page 6).

Now record your choice on the answer sheet. Also record the letter and page number of the next question to be answered. Then go to H or I on page 6.

E. The 32" bat was made from

1. aluminum (Question J, Page 7).
2. wood (Question K, Page 7).

Now record your choice on the answer sheet. Also record the letter and page number of the next question to be answered. Then go to J or K on page 7.

F. If you arrived here as the result of selecting Choice 1 of Question C your answer sheet should look like this.

Column I

Question A, Page 1

Choice 1

Question C, Page 4

Choice 1

Question F, Page 5

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question F.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

G. If you arrived here as the result of selecting Choice 2 of Question C your answer sheet should look like this.

Column I

Question A, Page 1

Choice 1

Question C, Page 4

Choice 2

Question G, Page 5

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question G.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

H. If you arrived here as the result of selecting Choice 1 of Question D your answer sheet should look like this.

Column I

Question A, Page 1

Choice 2

Question D, Page 4

Choice 1

Question H, Page 6

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question H.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

I. If you arrived here as the result of selecting Choice 2 of Question D your answer sheet should look like this.

Column I

Question A, Page 1

Choice 2

Question D, Page 4

Choice 2

Question I, Page 6

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question I.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

J. If you arrived here as the result of selecting Choice 1 of Question E, your answer sheet should look like this.

Column I

Question A, Page 1
Choice 3
Question E, Page 4
Choice 1
Question J, Page 7

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question J.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

K. If you arrived here as the result of selecting Choice 2 of Question E, your answer sheet should look like this.

Column I

Question A, Page 1
Choice 3
Question E, Page 4
Choice 2
Question K, Page 7

If your answer sheet doesn't look like this, please raise your hand.

Now answer Question K.

You can hit the ball the longest distance when it is thrown at

1. shoulder height (Question L, Page 8).
2. waist height (Question L, Page 8).
3. knee height (Question L, Page 8).

STOP! Wait until the tape recorder has been turned on before completing this page.

Remember your goal is to make a run. After you have completed page 8, wait until the tape recorder is turned on before reading page 9.

L. You swung at the first pitch. The ball is

1. fouled (Question M, Page 8).
2. swung at and missed (Question N, Page 8).
3. hit (Question O, Page 8).

M. The fouled ball

1. wasn't caught (Question N, Page 8).
2. went into the stands (Question N, Page 8).

N. The next ball was hit

1. toward first base (Question P, Page 8).
2. toward third base (Question P, Page 8).

O. The ball was hit toward

1. center field (Question Q, Page 8).
2. left field (Question Q, Page 8).

P. The ball was caught. You made the third out in the ninth inning. The game is over. Go to Page 9.

Q. The ball went over the outfield fence. You have made a home run. Your team has won the game. Go to Page 9.

STOP! Wait until the tape recorder has been turned on.

If you selected the decision route that resulted in your making a run, your answer sheet should look like this.

Starting with the dotted line found on your answer sheet, a 3 should have been recorded in the blank space next to the word Choice.

- - - - - - - - - - - - - - - - - - - -

Choice _3_

Question _0_, Page _8_

Choice _1 or 2_

Question _Q_, Page _8_

Since you have made a home run, the game is over. Thus, you have accomplished your goal and the example test has been completed.

The Answer Sheet for the decision-making test will include a Column II and a Column III, in case you wish to change your answers.

Suppose you have answered four questions on your Answer Sheet. Thus, your Answer Sheet would look like this.

Column I	Column II	Column III
Question A, Page 1	Question A, Page 1	Question A, Page 1
Choice 3	Choice ___	Choice ___
Question E, Page 2	Question ___, Page ___	Question ___, Page ___
Choice 2	Choice ___	Choice ___
Question L, Page 4	Question ___, Page ___	Question ___, Page ___
Choice 1	Choice ___	Choice ___
Question Q, Page 6	Question ___, Page ___	Question ___, Page ___
Choice 2	Choice ___	Choice ___

Also assume that you have decided to change Choice 2 for Question E, Page 2 to Choice 3. To change your Answer Sheet, cross out Choice 2 and all other selections found below Choice 2 in Column I. Your Answer Sheet would look like this.

Column I	Column II	Column III
Question A, Page 1	Question A, Page 1	Question A, Page 1
Choice 3	Choice ___	Choice ___
Question E, Page 2	Question ___, Page ___	Question ___, Page ___
~~Choice 2~~	Choice ___	Choice ___
~~Question D, Page 4~~	Question ___, Page ___	Question ___, Page ___
~~Choice 1~~	Choice ___	Choice ___
~~Question Q, Page 6~~	Question ___, Page ___	Question ___, Page ___
~~Choice 2~~	Choice ___	Choice ___

In Column II, record Choice 3 next to your previous Choice found in Column I. Also record the letter and page number of the next question to be answered below Choice 3.

Column I	Column II	Column III
Question A, Page 1	Question A, Page 1	Question A, Page 1
Choice 3	Choice ___	Choice ___
Question E, Page 2	Question ___, Page ___	Question ___, Page ___
~~Choice 2~~	Choice 3	Choice ___
~~Question L, Page 4~~	Question M, Page 5	Question ___, Page ___
~~Choice 1~~	Choice ___	Choice ___
~~Question Q, Page 6~~	Question ___, Page ___	Question ___, Page ___
~~Choice 2~~	Choice ___	Choice ___

Now, your answers would be recorded in Column II until you have finished the test, or wish to change another choice. Then Column III is used in the same manner as Column II was used. You are allowed to change your choices twice throughout the completion of the test.

II-A
PROGRAMMED DECISION INSTRUCTIONS
(ANSWER SHEET)

Column I

Question A, Page 1

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

- -

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

Question _____, Page _____

Choice _____

APPENDIX P

FINAL TASK TEST

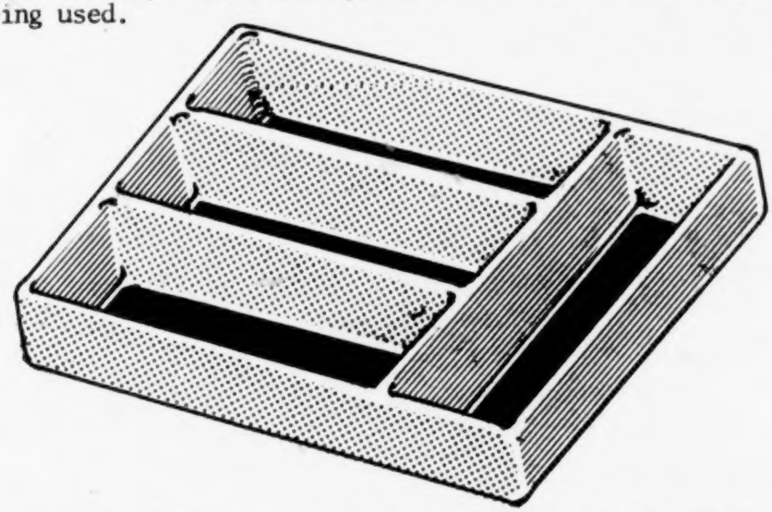
(Test Booklet)

III

FINAL TASK TEST
(TEST BOOKLET)

The Programmed Instruction Booklet has described the procedure to be used in taking this test.

This test will require you to identify the procedure you would use to make this silverware tray. The tray is used to store knives, forks, and spoons in a drawer while they are not being used.



The tray is to be produced by the process of thermoforming. I repeat, the tray is to be produced by the process of thermoforming.

Do not write in this test booklet. All answers are to be recorded on the answer sheet provided.

A. The material selected for making the silverware tray is

1. wood (Question B, Page 1).
2. plastic (Question C, Page 1).
3. metal (Question D, Page 1).

B. The type of wood used is

1. soft (Question E, Page 1).
2. hard (Question E, Page 1).

C. The type of plastic used is

1. thermoplastic (Question F, Page 2).
2. thermoset (Question G, Page 2).

D. The kind of metal used is

1. aluminum (Question H, Page 2).
2. copper (Question H, Page 2).
3. tin (Question H, Page 2).

E. The wood selected is in the form of

1. a powder --- sawdust (Question I, Page 2).
2. boards (Question J, Page 2).
3. veneer --- wood cut into sheets the thickness of paper (Question K, Page 3).

F. The thermoplastic plastic is in the form of a

1. sheet (Question L, Page 3).
2. powder (Question M, Page 3).
3. liquid (Question N, Page 3).

G. The thermoset plastic is in the form of a

1. sheet (Question O, Page 3).
2. powder (Question M, Page 3).
3. liquid (Question N, Page 3).

H. The metal is in the form of a

1. sheet (Question P, Page 4).
2. bar (Question Q, Page 4).
3. block --- piece of metal 1-1/2" thick by 10" wide by 12" long (Question R, Page 4).

I. The wood powder is

1. mixed with glue and pressed into a mold (Question S, Page 4).
2. mixed with a chemical and pressed into a mold (Question T, Page 4).

J. The wood board is

1. ground up into a powder, mixed with glue, and pressed into a mold (Question S, Page 4).
2. steamed, bent, and pressed into a mold (Question V, Page 5).

K. The wood veneer is

1. bent, glued, and pressed into a mold (Question W, Page 5).
2. treated with a chemical, bent, and pressed into a mold (Question U, Page 5).
3. steamed, bent, and pressed into a mold (Question V, Page 5).

L. The thermoplastic plastic sheet is

1. ground up into a powder, mixed with a glue, and pressed into a mold (Question S, Page 4).
2. melted into a jelly substance and injected into a mold (Question Y, Page 5).
3. softened and forced into a mold (Question X, Page 5).

M. The plastic powder is

1. melted into a jelly substance and injected into a mold (Question Y, Page 5).
2. mixed with a chemical and sprayed into a mold (Question Z, Page 6).
3. melted into a liquid and sprayed into a mold (Question AA, Page 6).

N. The plastic liquid is

1. mixed with a chemical and sprayed into a mold (Question Z, Page 6).
2. cast into a mold (Question AB, Page 6).

O. The thermoset plastic sheet is

1. ground up into a powder, mixed with a glue, and pressed into a mold (Question S, Page 4).
2. melted into a jelly substance and injected into a mold (Question Y, Page 5).
3. softened and forced into a mold (Question AC, Page 6).

P. The sheet metal is

1. heated, softened, and forced into a mold (Question AD, Page 6).
2. pressed into a mold (Question AE, Page 7).
3. melted into a liquid and cast into a mold (Question AF, Page 7).

Q. The bar of metal is

1. melted into a liquid and cast into a mold (Question AF, Page 7).
2. rolled into a sheet and pressed into a mold (Question AE, Page 7).
3. ground up, mixed with glue, and pressed into a mold (Question S, Page 4).

R. The block of metal is

1. ground up, mixed with glue, and pressed into a mold (Question S, Page 4).
2. milled to size and shape (Question AG, Page 7).

S. The powder is ground up until it becomes

1. course (Question AH, Page 7).
2. fine (Question AH, Page 7).
3. very fine (Question AH, Page 7).

T. The chemical dissolves the wood until it becomes

1. course paste (Question AI, Page 7).
2. fine paste (Question AI, Page 7).
3. very fine paste (Question AI, Page 7).

U. The chemical causes the veneer to become flexible in

1. three hours (Question AJ, Page 7).
2. seven hours (Question AJ, Page 7).

V. The steam causes the veneer or board to become flexible in

1. 12 hours (Question AJ, Page 7).
2. 24 hours (Question AJ, Page 7).

W. The veneer is cut into strips

1. 10" wide (Question AK, Page 7).
2. 14" wide (Question AK, Page 7).
3. 18" wide (Question AK, Page 7).

X. The thermoplastic plastic sheet is softened by the use of

1. a chemical (Question AX, Page 10).
2. heat (Question AL, Page 8).
3. water (Question AX, Page 10).

Y. The plastic is made into a jelly substance by the use of

1. heat (Question AN, Page 8).
2. a chemical (Question AN, Page 8).

Z. The plastic paste or liquid is sprayed into the mold while it is

1. cold (Question AO, Page 8).
2. warm (Question AO, Page 8).
3. hot (Question AO, Page 8).

AA. The melted plastic is sprayed into a mold while it is

1. cold (Question AO, Page 8).
2. warm (Question AO, Page 8).
3. hot (Question AO, Page 8).

AB. The casting plastic is mixed with

1. a resin (Question AP, Page 8).
2. a hardner (Question AP, Page 8).

AC. The thermoset plastic is softened by the use of

1. a chemical (Question AX, Page 10).
2. heat (Question AQ, Page 9).
3. water (Question AX, Page 10).

AD. The sheet metal is heated until it reaches its

1. flexible temperature (Question AR, Page 9).
2. shaping temperature (Question AR, Page 9).

AE. The sheet metal is pressed into a mold by the use of a

1. punch press (Question AS, Page 9).
2. drop forge hammer (Question AS, Page 9).

AF. The metal is cast in a mold made from

1. silicon and clay (Question AT, Page 9).
2. sand (Question AT, Page 9).

AG. The block is milled to shape by the use of a

1. vertical milling machine (Question AU, Page 9).
2. programmed milling machine (Question AU, Page 9).

AH. The powder is mixed with glue and pressed into a mold until it becomes

1. set (Question AV, Page 10).
2. cured (Question AV, Page 10).

AI. The paste is pressed into a mold until it becomes

1. set (Question AV, Page 10).
2. cured (Question AV, Page 10).

AJ. Next the veneer or wood board is pressed into a mold for

1. 12 hours (Question AW, Page 10).
2. 24 hours (Question AW, Page 10).

AK. After the glue has been applied to the strips, the veneer is pressed into a mold for

1. 1 hour (Question AW, Page 10).
2. 8 hours (Question AW, Page 10).

AL. The thermoplastic sheet is formed by

1. draping the softened plastic into a mold (Question AM, Page 8).
2. stretching the softened plastic against a mold (Question AY, Page 10).

AM. The plastic is softened by heating it to its

1. flexible temperature (Question AX, Page 10).
2. draping temperature (Question AX, Page 10).
3. bending temperature (Question AX, Page 10).

AN. After the plastic has been injected in the mold, the mold is cooled by the use of

1. air (Question AZ, Page 10).
2. water (Question AZ, Page 10).

AO. The plastic is allowed to set in the mold until it becomes

1. set (Question AV, Page 10).
2. cured (Question AV, Page 10).

AP. After the plastic has been poured, it remains in the mold until it becomes

1. set (Question AV, Page 10).
2. cured (Question AV, Page 10).

AQ. The plastic is formed by

1. draping the softened plastic into a mold (Question AM, Page 8).
2. stretching the softened plastic against a mold (Question BB, Page 11).

AR. The heated sheet metal is shaped by the use of a

1. punch press (Question AS, Page 9).
2. drop forge hammer (Question AS, Page 9).

AS. The pressed silverware tray is removed from the mold and

1. painted (Question TE, Page 14).
2. buffed (Question TE, Page 14).

AT. The metal is heated in a

1. crucible furnace (Question BC, Page 11).
2. electric furnace (Question BE, Page 11).

AU. The metal block is made smooth by

1. grinding (Question BD, Page 11).
2. sand blasting (Question BD, Page 11).

AV. After the silverware tray has been removed from the mold, it is

1. varnished (Question TE, Page 14).
2. coated with a liquid plastic (Question TE, Page 14).
3. painted (Question TE, Page 14).

AW. After the silverware tray has been removed from the mold, it is

1. varnished (Question TE, Page 14).
2. coated with a plastic spray (Question TE, Page 14).

AX. The plastic is forced into a mold and remains there until it becomes

1. cured (Question BI, Page 12).
2. cool and rigid (Question BI, Page 12).

AY. The thermoplastic sheet is heated until it

1. reaches its flexible temperature (Question BF, Page 11).
2. reaches its shaping temperature (Question BE, Page 11).
3. blisters (Question BF, Page 11).

AZ. The injected silverware tray is removed from the mold and

1. lacquered (Question TE, Page 14).
2. coated with a plastic spray (Question TE, Page 14).

BB. The sheet is heated until it

1. reaches its flexible temperature (Question BF, Page 11).
2. reaches its shaping temperature (Question BG, Page 12).
3. blisters (Question BF, Page 11).

BC. The metal is heated to

1. 1230 degrees (Question BH, Page 12).
2. 900 degrees (Question BH, Page 12).
3. 1540 degrees (Question BH, Page 12).

BD. Next, the metal silverware tray is

1. painted (Question TE, Page 14).
2. lacquered (Question TE, Page 14).

BE. The heated thermoplastic sheet is forced against the mold by the use of

1. air or vacuum (Question BK, Page 12).
2. mechanical leverage (Question BJ, Page 12).
3. a ram (Question BJ, Page 12).

BF. After the plastic has been placed in a mold, it is held until it becomes

1. cured (Question BI, Page 12).
2. cool and rigid (Question BI, Page 12).

BG. The heated plastic sheet is forced against the mold by the use of

1. air or vacuum (Question BL, Page 13).
2. mechanical leverage (Question BJ, Page 12).
3. a ram (Question BJ, Page 12).

BH. After the metal has been poured and removed from the mold, it is

1. sand blasted (Question BM, Page 13).
2. milled (Question BM, Page 13).

BI. After the silverware tray has been removed from the mold, it is sprayed with

1. lacquer (Question TE, Page 14).
2. plastic (Question TE, Page 14).

BJ. After the plastic silverware tray is removed from the mold, it is sprayed with

1. lacquer (Question TE, Page 14).
2. plastic (Question TE, Page 14).

BK. After the thermoplastic plastic has been stretched against the mold, air or vacuum is

1. maintained in the mold chamber (Question BN, Page 13).
2. allowed to escape from the mold chamber (Question BQ, Page 13).

BL. After the plastic sheet has been stretched against the mold, the air or vacuum is

1. maintained in the mold chamber (Question BO, Page 13).
2. allowed to escape the mold chamber (Question BQ, Page 13).

BM. The metal silverware tray is

1. painted (Question TE, Page 14).
2. lacquered (Question TE, Page 14).

BN. The air or vacuum is maintained in the chamber to allow the thermoplastic plastic to

1. cool (Question BR, Page 14).
2. cure (Question BT, Page 14).

BO. The air or vacuum is maintained in the chamber to allow the plastic to

1. cool (Question BS, Page 14).
2. cure (Question BT, Page 14).

BQ. The plastic silverware tray is sprayed with

1. lacquer (Question TE, Page 14).
2. plastic (Question TE, Page 14).

BR. The formed thermoplastic plastic silverware tray is removed from the mold after it has become

1. set (Question TE, Page 14).
2. cured (Question BT, Page 14).

BS. The formed plastic silverware tray is removed from the mold after it has become

1. set (Question TE, Page 14).
2. cured (Question BT, Page 14).

BT. The formed plastic silverware tray is

1. lacquered (Question TE, Page 14).
2. sprayed with a liquid plastic (Question TE, Page 14).

TE. THE END

III-A

FINAL TASK TEST
(ANSWER SHEET)

Name ______________________________ Grade _____ Section _______

Class Period ____________________ Teacher's Name ________________

School ______________________________ Date ________________

Column I	Column II	Column III
Question A, Page 1	Question A, Page 1	Question A, Page 1
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___
Question ___, Page ___	Question ___, Page ___	Question ___, Page ___
Choice ___	Choice ___	Choice ___

APPENDIX Q

TRANSFER TEST

(Test Booklet)

IV

TRANSFER TEST
(TEST BOOKLET)

Directions:

Enclosed are descriptions of different procedures for making products. Your task is to determine which descriptions involve or do not involve the use of thermoforming procedures. If the process described is thermoforming, record the word "True" on the accompanying answer sheet. If the process is not thermoforming, record the word "False" on the answer sheet.

For each description marked "False", you are to determine the reasons why the process is not thermoforming. The reasons are listed below each test item. The reasons include statements which are not related to the process of thermoforming.

To illustrate these directions, the following example test items are related to the process of yo-yoing. Yo-yoing involves:

1. the use of a yo-yo.
2. one end of the yo-yo string placed on the index finger,
3. allowing the string to unwind, and
4. jerking the string after it has unwound, causing the yo-yo to wind up the string.

An example test item, related to yo-yoing is:

I. "Around-the-world" is a trick that can be done with a yo-yo.

Since "around-the-world" is a trick involving the process of yo-yoing, "True" would be recorded on the answer sheet. The answer sheet would look like this.

I. True 1 2 3 4 5 6 7 8 9 10

Now record the word "True" for Example I on the answer sheet.

Another example test item is:

II. Henry loops a string over his index fingers so that two "X's" are formed. John, placing his fingers in the "X's", transfers the string to his hands, forming another design.

This description does not describe yo-yoing. Thus, the statement would be marked "False". The answer sheet would look like this.

II. False 1 2 3 4 5 6 7 8 9 10

Record "False" on the answer sheet for Example II.

Choices listed below Example question II are identified as reasons for marking the item "False." The reasons selected must be related to the yo-yo process.

The choices listed for Example question II are:

1. A yo-yo was not jerked.
2. Mats were not used.
3. The string was not fastened to the yo-yo.
4. A ball was not used.
5. A paddle was not used to bounce the ball.
6. A rubber band was not used to return the ball to the paddle.

Since choices 1 and 3 involve yo-yoing, the numbers 1 and 3 are circled on the answer sheet. The answer for Example II should look like this:

II. False ① 2 ③ 4 5 6 7 8 9 10

Now circle 1 and 3 on the answer sheet for Example II.

Select carefully your reason or reasons for marking a description "False". The number of incorrect reasons will be subtracted from the number of correct reasons. Mark all reasons you are sure about.

Base your answers on the information provided. For each description, take for granted that the mold will result in the production of a product.

Remember in answering each test item, first determine whether the process described is or is not thermoforming. If the process described is not thermoforming, mark the item "False." Then circle the number of the reason or reasons for marking the item "False."

DO NOT WRITE ON THIS TEST BOOKLET.

A. A measured amount of thermoset resin is placed in a mold. The mold is heated, pressure is applied, and the molten resin fills the mold cavity. A chemical reaction hardens the resin.

1. A thermoplastic material was not used.
2. Pellets were not used.
3. No sheet material was used.
4. The material was not heated until it became hard.
5. The material was not heated to its shaping temperature.
6. The material was not sprayed into the mold.
7. Air was not used to stretch the material against the mold.

B. A hopper is loaded with granular plastic materials. Heat is applied to the plastic until it becomes soft enough to flow. The softened plastic is forced through a nozzle in a mold cavity. When cured, the halves of the mold are separated.

1. No sheet material was used.
2. The material was not heated until it became hard.
3. The material was not heated to its shaping temperature.
4. The material was not sprayed into a mold.
5. The material was not stretched against a mold.
6. The material was not allowed to become set.
7. A catalyst was not used.

C. A softened thermoplastic jelly substance is forced between two or more long rollers. The rollers squeeze the plastic into sheets. When the plastic cools, it becomes rigid.

1. The material was not held against a mold while it set.
2. The material was not ground up.
3. The material was not draped in a mold.
4. No chemical was used to soften the material.
5. No sheet material was used.
6. The material was not stretched against a mold.
7. A catalyst was not used.

D. A plastic sheet is clamped to the top of a mold chamber. The plastic is heated to its shaping temperature. A vacuum draws the plastic against a mold. The vacuum is turned off when the plastic has become set.

1. No chemical was used to soften the material.
2. The material was not ground up.
3. The material was not allowed to cure.
4. Pellets were not used.
5. The material was not poured into a mold.
6. A thermoplastic material was not used.
7. The material was not softened by the use of steam.

E. A plastic material is fed into a heat exchanger. A ram forces the heated plastic through the heat exchanger into a mold. The mold is opened when the material has cured.

1. A thermoset plastic was not used.
2. The material was not heated to its flexible temperature.
3. The material was not heated to its shaping temperature.
4. The material was not heated to its blistering temperature.
5. Air was not used to stretch the material.
6. Air was not used to hold the stretched material against the mold.
7. The material was not draped into a mold.

F. A sheet is clamped to the top of a mold chamber. A hot plate, lowered against the sheet, heats the plastic until it can be stretched. Air forced through the hot plate forces the plastic against the mold. The air is trapped inside the mold chamber until the plastic has become set.

1. The material was not heated until it became flexible.
2. A thermoplastic was not used.
3. The material was not heated to its shaping temperature.
4. The material was not allowed to become cool and rigid.
5. The material was not allowed to cure.
6. The material was not poured into a mold.
7. Pellets were not used.

G. Plastic is clamped between two molds. As the molds close, heat and pressure cause the plastic to become soft. The mold is opened after the plastic has become set.

1. The material was not heated to its flexible temperature.
2. The material was not heated to its shaping temperature.
3. Air was not used to stretch the material.
4. Air was not used to hold the material against the mold.
5. The material was not allowed to cure.
6. The material was not draped into a mold.
7. The material was not allowed to become set.

H. A sheet of plastic is clamped over a mold and heated until it can be stretched. Air forced through the bottom of the mold forms a bubble. After the air is turned off, a vacuum draws the material against the mold. After the material has become set, the vacuum is turned off.

1. The material was not allowed to become cool and rigid.
2. The material was not heated until it became flexible.
3. The material was not heated to its shaping temperature.
4. Pellets were not used.
5. Air was not used to stretch the material against the mold.
6. No chemical was used to soften the material.
7. Air was not used to hold the stretched material against the mold.

IV-A

TRANSFER TASK TEST
(ANSWER SHEET)

Name ______________________ Grade _______ Section ____

Class Period ______________ Teacher's Name ______________

School ______________________ Date ______________

EXAMPLE:

I. ____________ 1 2 3 4 5 6 7 8 9 10

II. ____________ 1 2 3 4 5 6 7 8 9 10

A. ____________ 1 2 3 4 5 6 7 8 9 10

B. ____________ 1 2 3 4 5 6 7 8 9 10

C. ____________ 1 2 3 4 5 6 7 8 9 10

D. ____________ 1 2 3 4 5 6 7 8 9 10

E. ____________ 1 2 3 4 5 6 7 8 9 10

F. ____________ 1 2 3 4 5 6 7 8 9 10

G. ____________ 1 2 3 4 5 6 7 8 9 10

H. ____________ 1 2 3 4 5 6 7 8 9 10

APPENDIX R

LEARNING ACHIEVEMENT TEST

(Test Booklet)

V

LEARNING ACHIEVEMENT TEST
(TEST BOOKLET)

Directions:

This test consists of multiple choice questions. For each test item select the choice that best completes the statement. Circle the number of your choice on the answer sheet. Make sure your choice corresponds with the correct letter of the question found on the answer sheet.

Example Questions:

I. A ball and bat are used to play

1. soccer
2. football
3. basketball
4. baseball

For the Example Question I, circle choice 4 on the answer sheet.

II. A "pigskin" is used to play

1. soccer
2. football
3. basketball
4. baseball

Circle choice 2 on the answer sheet for Example Question II.

If you wish to change an answer, draw a line through the numbers and write your choice in the space provided.

II. ~~① 2 3 4 5~~ _2_

DO NOT WRITE ON THIS TEST BOOKLET.

A. Heat is

1. a race between two cars.
2. a process.
3. being sweaty after a race.
4. a furnace.

B. Heat results in

1. winning a race.
2. hardening a material.
3. producing light.
4. raising the warmth of a material.

C. Which of the following can be classified as a sheet?

1. a piece of metal 3/4" thick by 10" wide by 10" long.
2. a piece of metal 2" thick by 2" wide by 2" long.
3. a piece of metal 1" thick by 1" wide by 10" long.
4. a piece of metal 6" thick by 4" wide by 12" long.

D. Materials can be identified as sheets when the thickness is

1. less than the length, but more than the width.
2. less than the width, but more than the length.
3. more than the width or length.
4. less than the width or length.

E. Which of the following are related in some manner?

1. a piece of paper, a plywood box, and a plastic pipe.
2. a piece of cardboard, a magazine, and a bath towel.
3. a bar of metal, a cardboard box, and a magazine.
4. a plywood box, a plastic pipe, and a dish towel.

F. Sheet materials heated to the same temperature will result in heat having

1. a different effect on different materials.
2. the same effect on different materials.
3. a different effect on the same materials.

G. Low temperature (230 degrees) will cause some plastic sheets to become

1. flexible.
2. hard.
3. a liquid.
4. a gas.
5. cured.

H. A thermoplastic plastic, when heated, will become

1. rubbery.
2. hard.
3. a liquid.
4. a gas.
5. cured.

I. Thermoplastic plastic sheets that have reached their shaping temperature will become

1. bubbly and blistered.
2. a liquid.
3. flexible.
4. stretchable.
5. a gas.

J. Thermoplastic plastic sheets that have been heated above their shaping temperature will become

1. bubbly and blistered.
2. flexible.
3. a liquid.
4. stretchable.
5. a gas.

K. A thermoplastic plastic sheet becomes ideal for making a product when it has reached its

1. flexible temperature.
2. shaping temperature.
3. blistering temperature.

L. Heated thermoplastic plastic sheets that have "set" have become

1. warm and flexible.
2. cool and flexible.
3. warm and stretchable.
4. cool and hard.
5. warm and rigid.

M. A thermoplastic plastic sauce dish that has "set" will

1. break before it can be flatened.
2. have changed from a liquid to a jelly substance.
3. be hot and rigid.
4. remain in the same place for a long period of time.

N. Force involves a

1. push being exerted.
2. pull being exerted.
3. push or pull being exerted.
4. push or pull being exerted against a resistance.

O. A force is exerted when the amount of

1. push is greater than the resistance.
2. push is less than the resistance.
3. pull is less than the resistance.
4. pull is equal to the resistance.

P. An example of force is a man

1. leaning against a house.
2. pushing a lawn mower.
3. striking a concrete wall with his fist.
4. flexing his muscles.

Q. An air-tight chamber is needed to apply a force by the use of

1. air or vacuum.
2. air or mechanical leverage.
3. vacuum or mechanical leverage.
4. air, vacuum, or mechanical leverage.

R. The absence of air is involved in exerting a force when one uses

1. compressed air.
2. a vacuum.
3. compressed air or vacuum.
4. mechanical leverage or compressed air.
5. compressed air, vacuum, or mechanical leverage.

S. A force can be exerted when the amount of compressed air is

1. equal to the resistance.
2. less than the resistance.
3. equal to or less than the resistance.
4. greater than the resistance.

T. A mold is

1. a green fungus growing on a product.
2. a model for a product.
3 marks left by an animal under the surface of a material.
4. a bump under the surface of a material.

U. A mold will

1. produce green fungus growing on a product.
2. produce the outside surface of a product.
3. produce the inside surface of a product.
4. produce the inside or outside surface of a product.
5. leave marks under the surface of a material.

V. The product created from a mold

1. must be smaller than the mold.
2. will have surfaces similar to the mold.
3. will be identical with, not similar to, the mold.
4. will kill germs upon contact with them.

W. The shape of a product is related to

1. a shadow cast by the product.
2. the material of the product.
3. the color and the material of the product.
4. a shadow cast and the material of the product.

X. The shape of a product includes the

1. material of the product.
2. the color and the material of the product.
3. overall size and surface detail of the product.
4. overall size, material, and surface detail of the product.

Y. Which of the following describes the shape of a product?

1. a white candy dish 2" high by 6" wide by 7" long.
2. a glass ash tray 3/4" high by 4" wide by 6" long.
3. a smooth surfaced, oval soap dish 1/4" high by 2" wide by 6" long.
4. a peanut dish 2" high by 3" wide and 6" long.

Z. A sheet of rubber clamped over a mold will conform to the shape of the mold when

1. treated with a chemical (catalyst).
2. rubbed with a felt cloth.
3. a vacuum is created through the mold.
4. the clamp is released.

AA. To reproduce the shape of a mold, a piece of rubber must be

1. thin.
2. flexible.
3. stretchable.
4. soft.

BB. Sheet materials can be held against a mold when compressed air has been trapped

1. below the mold.
2. between the mold and the sheet material.
3. above the sheet material.

CC. A sheet material forced against a mold by air will maintain the shape of the mold if

1. the mold remains cool.
2. the material is rubbed with a felt cloth.
3. the clamp remains released.
4. there are no air leaks.
5. the catalyst is present.

DD. A thermoplastic plastic sheet can be formed by

1. cutting, softening, and draping the plastic in a mold.
2. using air to stretch the heated plastic against a mold.
3. heating and pouring the plastic into a mold.
4. treating the plastic with a catalyst and pouring it into a mold.

EE. The forming of a thermoplastic plastic sheet includes

1. cutting, heating, and draping the plastic in a mold.
2. heating the plastic to its flexible temperature and draping it in a mold.
3. heating the plastic to its shaping temperature and forcing it against a mold.
4. heating the plastic until it bubbles and pouring it into a mold.
5. treating the plastic with a catalyst and pouring it into a mold.

FF. A formed thermoplastic plastic sheet will maintain the shape of a mold when

1. a force is used to hold the draped plastic against the mold while it cools.
2. compressed air is used to hold the stretched plastic against a mold while it becomes set.
3. The plastic turns from a liquid to a solid as it cools.
4. the catalyst causes the material to change from a jelly substance into a solid.

GG. The forming of a thermoplastic plastic sheet includes

1. using a wooden ram to hold the draped plastic against a mold while it cools.
2. using a vacuum to hold stretched plastic against a mold while it sets.
3. using the loss of heat to turn a liquid into a solid.
4. using a chemical reaction to turn a liquid into a solid.

HH. Thermoforming involves the use of

1. heat, mold, and thermoplastic plastic to make a product.
2. heat, mold, thermoplastic plastic sheets, air or vacuum, and force to make a product.
3. heat, liquid thermoplastic, and a mold to make a product.
4. heat, mold, catalyst, and liquid thermoplastic to make a product.

V-A

LEARNING ACHIEVEMENT TEST
(ANSWER SHEET)

Name ______________________________ Grade ______ Section _____

Class Period __________________ Teacher's Name ____________________

School ______________________________ Date ____________________

EXAMPLE:

I. 1 2 3 4 5 ______
II. 1 2 3 4 5 ______

A. 1 2 3 4 5 ______
B. 1 2 3 4 5 ______
C. 1 2 3 4 5 ______
D. 1 2 3 4 5 ______
E. 1 2 3 4 5 ______
F. 1 2 3 4 5 ______
G. 1 2 3 4 5 ______
H. 1 2 3 4 5 ______
I. 1 2 3 4 5 ______
J. 1 2 3 4 5 ______
K. 1 2 3 4 5 ______
L. 1 2 3 4 5 ______
M. 1 2 3 4 5 ______
N. 1 2 3 4 5 ______
O. 1 2 3 4 5 ______
P. 1 2 3 4 5 ______
Q. 1 2 3 4 5 ______
R. 1 2 3 4 5 ______
S. 1 2 3 4 5 ______
T. 1 2 3 4 5 ______
U. 1 2 3 4 5 ______
V. 1 2 3 4 5 ______
W. 1 2 3 4 5 ______
X. 1 2 3 4 5 ______
Y. 1 2 3 4 5 ______
Z. 1 2 3 4 5 ______
AA. 1 2 3 4 5 ______
BB. 1 2 3 4 5 ______
CC. 1 2 3 4 5 ______
DD. 1 2 3 4 5 ______
EE. 1 2 3 4 5
FF. 1 2 3 4 5 ______
GG. 1 2 3 4 5 ______
HH. 1 2 3 4 5 ______
II. 1 2 3 4 5 ______
JJ. 1 2 3 4 5 ______
KK. 1 2 3 4 5 ______
LL. 1 2 3 4 5 ______
MM. 1 2 3 4 5 ______
NN. 1 2 3 4 5 ______
OO. 1 2 3 4 5 ______
PP. 1 2 3 4 5 ______
QQ. 1 2 3 4 5 ______
RR. 1 2 3 4 5 ______
SS. 1 2 3 4 5 ______
TT. 1 2 3 4 5 ______

APPENDIX S

TEACHERS' INSTRUCTIONAL BOOKLET PER TREATMENT

SCHEDULE OF ACTIVITIES

Teacher ____________________ School ______________

Class Periods Selected ____________________________

	Monday	Tuesday	Wednesday	Thursday	Friday
1					
2					
3					
4					
5					
6					
7					
8					

(1, 2, 3, & 4)

GENERAL INSTRUCTIONS

The administering of the treatment consists of (1) showing a video-tape and (2) giving tests to each class that has been randomly selected. The video-tape is 40 - 42 minutes in length. The completion of the tests should take about two class periods.

The activities for administering the treatment are as follows:

First 45-minute period

- Show video-tape

Second 45-minute period

- Administer the following:
  1. Learning Tasks, I-B (10 to 12 minutes);
  2. Programmed Instructions, II, for taking Final Task Test (15 to 20 minutes);
  3. Final Task Test, III (10 to 15 minutes).

Third 45-minute period

- Administer the following:
  1. Transfer Task Test, IV (15 to 18 minutes);
  2. Learning Achievement Test, V (20 to 25 minutes).

The time is an estimate of how long the tests should take. The Roman numerals are codes for referring to the different tests.

The Learning Task Sheet (I-B) consists of 13 fill-in-the-blank statements. The statements are the programmed learning tasks that are included in the video-tape.

The Programmed Instruction Booklet (II) consists of instructions for taking the Final Task Test (III). The Final Task Test (III) is a programmed decision-making test. The format of the test is similar to a multiple-choice test, except that the selection of a choice determines the next question to be answered. The test items are not completed in consecutive order. Once the students understand the directions, they will complete the Final Task Test in 8 to 10 minutes.

(1 & 2)

The Transfer Test (IV) consists of true and false test items. If the students mark an item false, they are asked to identify reasons for their decision. The strategy the students should use to take the test is to, first make a decision whether the item is true or false, and then determine the reasons for marking the item false. Reading the list of reasons for marking the item false before making a decision will cause confusion.

The Learning Achievement Test (V) consists of multiple-choice test items. The students are required to select the best choice.

The Learning Task Booklet (I-B), Programmed Instruction Booklet (II), Final Task Test Booklet (III), Transfer Test Booklet (IV), and Learning Achievement Test Booklet (V) have been recorded on an audio-tape at the 3-3/4 speed. The tape has been included to (1) help the students take the tests, (2) insure the same procedure will be used to give the tests, and (3) help you administer the tests.

The remainder of this booklet identifies specific details to be completed by you while you administer the treatment. The specific details per activity are identified by check lists. It is suggested that you read this booklet thoroughly before administering the treatment. It is imperative that you listen to the audio-tape through the first true and false item on the Transfer Test (IV).

If the Programmed Instruction Booklet (II) takes more than the estimated time, give the Final Task Test (III) and the Transfer Test (IV) on the third 45-minute period. Give the Learning Achievement Test (V) during the fourth 45-minute period. It is more important that the students understand the directions for taking the Final Task Test (III) than for them to take the test without understanding the directions.

Your role in preparing the students for participating in this study and administering the treatment is greatly appreciated. Your "pep talk" should have encouraged the students to do their best. Not including thermoforming in your industrial arts program has helped to maintain the validity of the study.

Thank you for your fine cooperation.

(1 & 2)

GENERAL INSTRUCTIONS

The administering of the treatment consists of (1) showing a video-tape and (2) giving tests to each class that has been randomly selected. The video-tape is 40 - 42 minutes in length. The completion of the tests should take about two class periods.

The activities for administering the treatment are as follows:

First 45-minute period

- Show video-tape.

Second 45-minute period

- Administer the following:
    1. Programmed Instructions, II, for taking the Final Task Test (15 to 20 minutes);
    2. Final Task Test, III (10 to 15 minutes).

Third 45-minute period

- Administer the following:
    1. Transfer Task Test, IV (15 to 18 minutes);
    2. Learning Achievement Test, V (20 - 25 minutes).

The time is an estimate of how long the tests should take. The Roman numerals are codes for referring to the different tests.

The Programmed Instruction Booklet (II) consists of instructions for taking the Final Task Test (III). The Final Task Test (III) is a programmed decision-making test. The format of the test is similar to a multiple-choice test, except that the selection of a choice determines the next question to be answered. The test items are not completed in consecutive order. Once the students understand the directions, they will complete the Final Task Test in 8 to 10 minutes.

The Transfer Test (IV) consists of true and false test items. If the students mark an item false, they are asked to identify reasons for their decision. The strategy the students should use to take the test is to, first make a decision whether the item is true or false, and then determine the reasons for marking the item false. Reading the list of reasons for marking the item false before making a decision will cause confusion.

The Learning Achievement Test (V) consists of multiple- choice test items. The students are required to select the best choice.

The Programmed Instruction Booklet (II), Final Task Test Booklet (III), Transfer Test Booklet (IV), and Learning Achievement Test Booklet (V) have been recorded on an audio-tape at the 3-3/4 speed. The tape has been included to (1) help the students take the tests, (2) insure the same procedure will be used to give the tests, and (3) help you administer the tests.

The remainder of this booklet identifies specific details to be completed by you while you administer the treatment. The specific details per activity are identified by check lists. It is suggested that you read this booklet thoroughly before administering the treatment. It is imperative that you listen to the audio-tape through the first true and false item on the Transfer Test (IV).

If the Programmed Instruction Booklet (II) takes more than the estimated time, give the Final Task Test (III) and the Transfer Test (IV) on the third 45-minute period. Give the Learning Achievement Test (V) during the fourth 45-minute period. It is more important that the students understand the directions for taking the Final Task Test (III) than for them to take the test without understanding the directions.

Your role in preparing the students for participating in this study and administering the treatment is greatly appreciated. Your "pep talk" should have encouraged the students to do their best. Not including thermoforming in your industrial arts program has helped to maintain the validity of the study.

Thank you for your fine cooperation.

GENERAL INSTRUCTIONS

The administering of the treatment consists of giving tests to each class that has been randomly selected. The completion of the tests should take about two class periods.

The activities for administering the treatment are as follows:

First 45-minute period

- Administer the following:
  1. Programmed Instructions, II, for taking the Final Task Test (15 to 20 minutes);
  2. Final Task Test, III (10 to 15 minutes).

Second 45-minute period

- Administer the following:
  1. Transfer Task Test, IV (15 to 18 minutes);
  2. Learning Achievement Test, V (20 to 25 minutes).

The time is an estimate of how long the tests should take. The Roman numerals are codes for referring to the different tests.

The Programmed Instruction Booklet (II) includes instructions for taking the Final Task Test (III). The Final Task Test (III) is a programmed decision-making test. The format of the test is similar to a multiple-choice test, except the selection of a choice determines the next question to be answered. The test items are not completed in consecutive order. Once the students understand the directions, they will complete the Final Task Test in 8 to 10 minutes.

The Transfer Test (IV) consists of true and false test items. If the students mark an item false, they are asked to identify reasons for their decision. The strategy the students should use to take the test is first make a decision whether the item is true or false, and then determine the reasons for marking the item false. Reading the list of reasons for marking the item false before making a decision will cause confusion.

The Learning Achievement Test (V) consists of multiple-choice test items. The students are required to select the best choice.

The Programmed Instruction Booklet (II), Final Task Test Booklet (III), Transfer Test Booklet (IV), and Learning Achievement Test Booklet have been recorded on an audio-tape at the 3-3/4 speed. The tape has been included to (1) help the students take the tests, (2) insure the same procedure will be used to give the tests, and (3) help you administer the tests.

The remainder of this booklet identifies specific details to be completed by you while you administer the treatment. The specific details per activity are identified by check lists. It is suggested that you read this booklet thoroughly before administering the treatment. It is imperative that you listen to the audio-tape through the first two true and false items on the Transfer Test (IV).

If the Programmed Instruction Booklet (II) takes more than the estimated time, give the Final Task Test (III) and the Transfer Test (IV) on the second 45-minute period. Give the Learning Achievement Test (V) during the third 45-minute period. It is more important that the students understand the directions for taking the Final Task Test (III) than for them to take the test without understanding the directions.

Your role in preparing the students for participating in this study and administering the treatment is greatly appreciated. Your "pep talk" should have encouraged the students to do their best. Not including thermoforming in your industrial arts program has helped to maintain the validity of the study.

Thank you for your fine cooperation.

ATTENDANCE SLIPS

Enclosed you will find a form for recording the names of students enrolled in each class period that has been randomly selected. Please list the students in alphabetical order in the left-hand column. If a student was absent the day the video tape was given, please record "Ab" in the column entitled lesson. The remaining columns will be used to record the results of the tests. Student absences for the days the tests are administered will be determined by no answer sheets being turned in.

(1, 2, & 3)

ATTENDANCE SLIPS

Enclosed you will find a form for recording names of students enrolled in each class period that has been randomly selected. Please list the students in alphabetical order in the left-hand column. Student absences for the days the tests are administered will be determined by no answer sheets being turned in.

(4)

ATTENDANCE

Teacher's Name ____________________

School ____________________ Class Period ________

Students	Lesson	F.T.T.	T.T.	L.A.T.	Assigned Student No.
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					

(1,2,3,4)

CHECK LIST FOR SHOWING THE VIDEO-TAPE

Before the class period begins have the video-tape machine and monitor ready. The video tape should be positioned on the single line title slide. Next, Mr. O'Hara will appear on the screen. You should have your attendance sheet and hand-out sheet I-A, Learning Task Diagram. The tape will take 40 to 42 minutes.

Since the production of the video-tape a minor change has been made. In the introduction, Mr. O'Hara states that the students should have two hand-out sheets in front of them. The second hand-out sheet, I-B, will be handed out during the first period of testing. The completion of the Learning Task Sheet (I-B) during the video-tape presentation has resulted in the students not focusing their full attention on the video-tape presentation. The accompanying check list identifies when you should inform the students about the change.

Check List

_____ Remind the students how important it is for them to pay attention throughout the video-tape presentation.

_____ Hand out the Learning Task Diagram (I-A).

_____ Inform the students that Mr. O'Hara will state in the introduction of the lesson that they should have two hand-out sheets in front of them throughout the lesson. Since the tape has been made, this has been changed. You will have only one hand-out sheet. The second sheet will be handed out during the next industrial arts class period.

_____ Turn on the video-tape machine.

_____ Stop the video-tape machine when Mr. O'Hara gets to the example learning task. Here, Mr. O'Hara will inform the students to complete the example task on the Learning Task Sheet. Inform the students that they should complete this learning task and the remaining tasks by watching the TV screen.

_____ Turn on the video-tape machine.

_____ Take attendance while the tape is playing.

_____ After the tape has ended, rewind the tape.

(1 & 2)

CHECK LIST FOR SHOWING THE VIDEO-TAPE

Before the class period begins have the video-tape machine and the monitor ready. The video-tape should be positioned on the single line title slide. Next, Mr. O'Hara will appear on the screen. You should have your attendance sheet and hand-out sheet I, Plan Sheet for Constructing the Candy Dish. The tape will take 40 minutes.

Check List

_____ Remind the students how important it is for them to pay attention throughout the video-tape presentation.

_____ Hand out the Plan Sheet (I).

_____ Inform the students that the hand-out is for them to keep in their notebook.

_____ Turn on the video-tape machine.

_____ Take attendance while the tape is playing.

_____ After the tape has ended, rewind the tape.

(3)

CHECK LIST FOR FIRST DAY OF TESTING

Before the class begins, have the following items:

_____ 1 tape recorder

_____ 1 audio-tape

_____ extra pencils for the students to use

_____ Learning Task Booklet (I-B)

_____ Programmed Instruction Booklet (II)

_____ Programmed Instruction Answer Sheet (II-A)

_____ Final Task Test (III)

_____ Final Task Test Answer Sheet (III-A)

The tape recorder should be ready to be played. The information that the students will need to complete the heading of the Final Task Answer sheet (III-A) should be on the blackboard.

Check List

_____ Hand out the Learning Task Booklet (I-B).

_____ While handing out the booklet, inform the students that the directions for completing these tasks and taking the tests have been recorded on an audio-tape. Thus, they will need to pay close attention to the taped instructions.

_____ Inform the students that Mr. O'Hara will present a short introduction to the tests on the tape. Then he will read the handout sheet.

_____ Inform the students that they are to read the hand-out sheet as they listen to the tape. Mr. O'Hara will inform them when to complete each task.

_____ Turn on the tape recorder.

_____ When the Learning Task Sheet (II-B) has been completed, turn off the tape recorder.

_____ Ask the students to write their name on the Learning Task Sheet.

_____ Inform the students that they will receive these sheets at the end of the period.

(1&2)

_____ Pick up the Learning Task Sheet and hand out the Programmed Instruction Booklet (II) and Answer Sheet (II-A).

_____ Inform the students that the instructions are on tape. Throughout the completion of the booklet, the tape will be turned off while they answer some questions. Ask them to follow instructions carefully.

_____ Turn on the tape recorder.

_____ Turn off the tape recorder at the end of Page 3.

_____ Answer any questions the students have while they complete Pages 4 - 7.

_____ After all students have completed Page 7, turn on the tape recorder. The first paragraph on Page 8 will be read.

_____ After the paragraph has been read, turn off the tape recorder.

_____ After all of the students have finished Page 8, turn on the tape recorder.

_____ Turn off the tape recorder after the Programmed Instruction Booklet (II) has been completed.

_____ Collect the Programmed Instruction Booklets (II) and Answer Sheets (II-A) and hand out the Final Task Test (III) and Answer Sheet (III-A).

_____ Have the students fill out the heading of the Final Task Answer Sheet (III-A). Inform them that the information they need for completing the heading is on the blackboard.

_____ Turn on the tape recorder.

_____ At the end of the first page of the Final Task Test, turn off the tape recorder.

_____ Collect the Final Task Test Booklets (III) and Answer Sheets (III-A) when the students complete the test.

_____ Hand out the Learning Task Booklet (I-B) at the end of the class period.

(1&2)

CHECK LIST FOR FIRST DAY OF TESTING

Before the class period begins, have the following items:

_____ 1 tape recorder

_____ 1 audio tape

_____ extra pencils for the students to use

_____ Programmed Instruction Booklet (II)

_____ Programmed Instruction Answer Sheet (II-A)

_____ Final Task Test (III)

_____ Final Task Test Answer Sheet (III-A)

The tape recorder should be ready to be played. The information the students will need to complete the heading of the Final Task Answer Sheet (III-A) should be on the blackboard.

Check List

_____ Hand out the Programmed Instruction Booklet (II) and Answer Sheet (II-A).

_____ Inform the students that the directions for completing this example test have been recorded on tape. Thus, they will need to pay close attention to the taped instructions.

_____ Inform the students that throughout the completion of the booklet, the tape will be turned off while they answer some questions.

_____ Turn on the tape recorder.

_____ Turn off the tape recorder at the end of Page 3.

_____ Answer any questions the students have while they complete Pages 4 - 7.

_____ After all students have completed Page 7, turn on the tape recorder. The first paragraph on Page 8 will be read.

_____ After the paragraph has been read, turn off the tape recorder.

_____ After all of the students have finished Page 8, turn on the tape recorder.

(3&4)

_____ Turn off the tape recorder after the Programmed Instruction Booklet (II) has been completed.

_____ Collect the Programmed Instruction Booklet (II) and Answer Sheets (II-A) and hand out the Final Task Test (III) and Answer Sheets (III-A).

_____ Have the students fill out the heading of the Final Task Answer Sheet (III-A). Inform them that the information they need for completing the heading is on the blackboard.

_____ Turn on the tape recorder.

_____ At the end of the first page of the Final Task Test turn off the tape recorder.

_____ Collect the Final Task Test Booklets (III) and Answer Sheets (III-A) when the students complete the test.

(3&4)

CHECK LIST FOR SECOND DAY OF TESTING

Before the class period begins, have the following items:

_____ 1 tape recorder

_____ 1 audio-tape

_____ extra pencils for students to use

_____ Transfer Test Booklets (IV)

_____ Transfer Test Answer Sheets (IV-A)

_____ Learning Achievement Test (IV)

_____ Learning Achievement Test Answer Sheets (V-A)

The tape recorder should be ready to play. The information the students will need to complete the heading on the answer sheets should be on the blackboard.

Check List

_____ Hand out the Transfer Test Booklets (IV) and Answer Sheets (IV-A).

_____ Remind the students to follow the directions on the tape. Also to read the test booklet while they listen to the tape.

_____ Turn on the tape recorder.

_____ Turn off the tape recorder after Mr. O'Hara has read Question A and has said, "Now determine if this is or isn't a thermoforming procedure. If you think this is a thermoforming procedure, record true on your answer sheet. If you don't think this is a thermoforming procedure, record false on the answer sheet.

_____ Wait until the students have recorded True or False on the Answer Sheet. If they are slow about doing this, inform them that they are to record True or False on their Answer Sheet before completing the rest of the test item.

_____ Turn on the tape recorder.

_____ When the test has been completed, turn off the tape recorder.

_____ Collect the Transfer Test Booklets (IV) and Answer Sheets (IV-A) and hand out the Learning Achievement Test Booklets (V) and Answer Sheets (V-A).

(1,2,3,&4)

_____ Remind the students to listen to the tape recorder while they read this test.

_____ Turn on the tape recorder.

_____ Turn off the tape recorder at the end of the test.

_____ Collect the Learning Achievement Test Booklets (V) and Answer Sheets (V-A).

_____ Thank the students for their cooperation.

(1,2,3,&4)

APPENDIX T

JUNIOR HIGH STUDENT PERSONAL DATA SHEET

JUNIOR HIGH
STUDENT PERSONAL DATA SHEET

Student No. ______________ Sex ____ Birth: Yr. ____ Mo. ____ Day ____

Father's Occupation ________________ Mother's Occupation ___________ Guardian's Occupation __________

Address: ____

GRADES:

Elementary School			
Year	4	5	6
Reading			
Writing			
Spelling			
Language			
Mathematics			
Science			
Social St.			

Junior High School		
Year	7	8
English		
World Regions		
Mathematics		
Science		
I. A.		
Art		
Music		
Phys.Ed.		
Foreign Lang.		
M. D.		

I.Q. TEST SCORES:

Date	Grade	Chron. Age	Intelligence Tests	Raw Score	I. Q.	%ile	Norm.
			Otis Q. S., Alpha				Nat.
			Otis-Lennon II, J				Nat.

ACHIEVEMENT TEST SCORES:

Date	Grade	Chron. Age	Ed. Dev. Series	Raw Score	S	Grade Score	Norm.
			Non-verbal				
			Verbal				
			Reading				
			English				
			Mathematics				
CODE			Science				
			U.S.A.				
			Solving Problems				
			Composite				
			Total Ability				
			Basic Skills				
Date	Grade	Chron. Age	Stanford Acht., Inter. II, W	Grade Equiv.	%ile	S	Norm.
			Word M.				
			Para. M.				
			Spelling				
			Word Study Skills				
			Language				
			Arith. Comp.				
			Arith. Conc.				
			Arith. Appli.				
			Social St.				
			Science				
			Median				

APPENDIX U

SENIOR HIGH STUDENT PERSONAL DATA SHEET

SENIOR HIGH STUDENT PERSONAL DATA SHEET

Grade: 10 11 12

Student No. ____________ Sex______ Date of Birth: Yr.____ Mo.____ Day____

Father's Occupation:______________ Mother's Occupation:_________ Guardian's Occupation:_________

Address:____

GRADES:

Junior High School		
Year	7	8
English		
World Regions/History		
Math.		
Science		
Home Ec.		
I. A.		
Art		
Music		
Phys. Ed.		
For. Lang.		
M. D.		

Ninth		Tenth		Eleventh	
English		English		English	
Am. Studies I		Am. Studies II		World Cult. I	
Algebra I		Plane Geom.		Algebra II	
Math.		Biology		Physics	
Gen. Science		G. Bus.		Sh. I - Bk.	
Phys. Ed.		Phys. Ed.		Type I	
				Phys. Ed.	

I. Q. SCORES:

Date	Grade	Chron. Age	Intelligence Tests	Raw Score	I. Q.	Norm.
			Otis Q.S., Beta			Nat.
			Otis-Lennon II, J			Nat.

ACHIEVEMENT TEST SCORES:

Date	Grade	Chron. Age	Stanford Acht., Inter. II, W	Grade Equiv.	%ile	S
			Word. M.			
			Para. M.			
			Spelling			
NORM			Language			
			Arith. Comp.			
			Arith. Conc.			
			Arith. Appli.			
			Social St.			
			Science			
			Median			

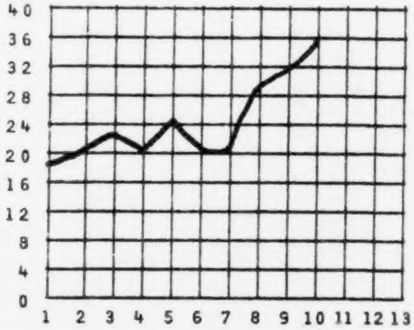
Date	Grade	Chron. Age	Ed. Dev. Series	Score	S	Grade Score
			Non-verbal			
			Verbal			
			Reading			
NORM			English			
			Math.			
			Science			
CODE			U.S.A.			
			Solving Problems			
			Composite			
			Total Ability			
			Basic Skills			

APPENDIX V

ITEM DISCRIMINATION CURVES, DISCRIMINATION INDEXES, DIFFICULTY INDEXES, AND ITEM-SCORE CORRELATIONS USED TO EVALUATE THE LEARNING ACHIEVEMENT TEST ADMINISTERED TO JUNIOR HIGH STUDENTS

ITEM DISCRIMINATION CURVES, DISCRIMINATION INDEXES, DIFFICULTY INDEXES, AND ITEM-SCORE CORRELATIONS USED TO EVALUATE THE LEARNING ACHIEVEMENT TEST ADMINISTERED TO JUNIOR HIGH STUDENTS

Question 1

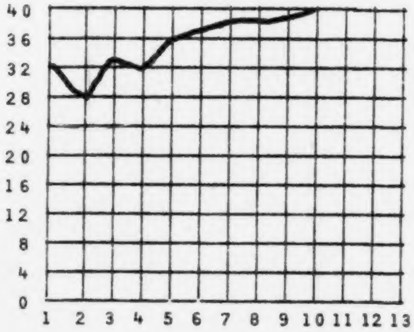


D. I. = .63

Disc. I = .16

Item-Score Corr. = .39

Question 2

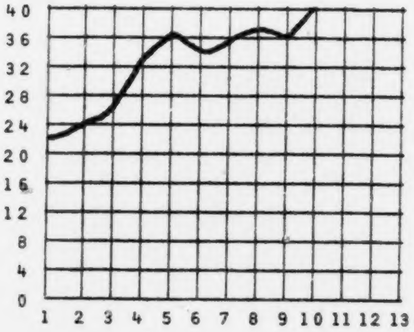


D. I. = .89

Disc. I = .15

Item-Score Corr. = .35

Question 3

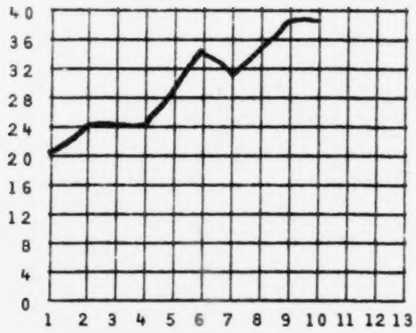


D. I. = .81

Disc. I = .21

Item-Score Corr. = .51

Question 4

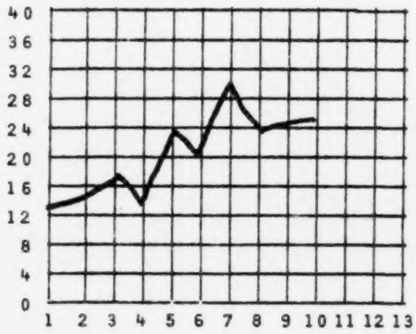


D. I. = .78

Disc. I = .27

Item-Score Corr. = .54

Question 5

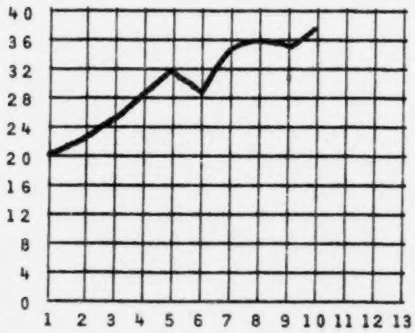


D. I. = .52

Disc. I = .21

Item-Score Corr. = .25

Question 6

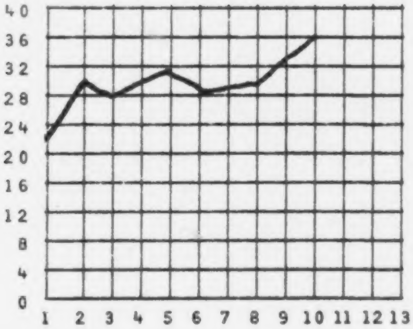


D. I. = .73

Disc. I = .23

Item-Score Corr. = .42

Question 7

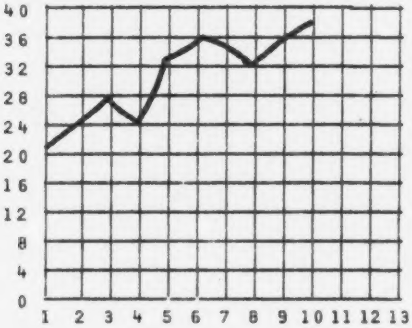


D. I. = .74

Disc. I = .08

Item-Score Corr. = .30

Question 8

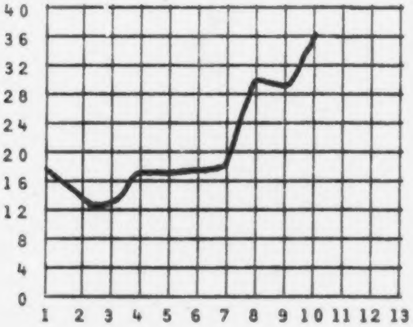


D. I. = .77

Disc. I = .22

Item-Score Corr. = .36

Question 9

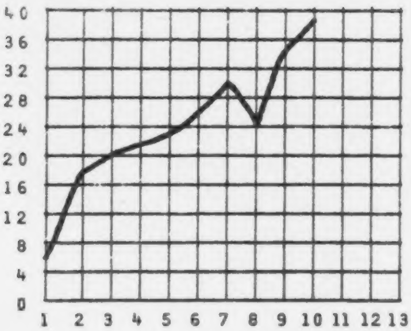


D. I. = .51

Disc. I = .25

Item-Score Corr. = .35

Question 10

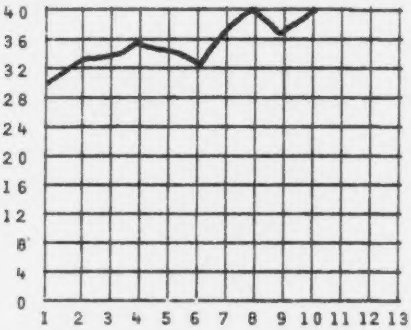


D. I. = .60

Disc. I = .32

Item-Score Corr. = .46

Question 11

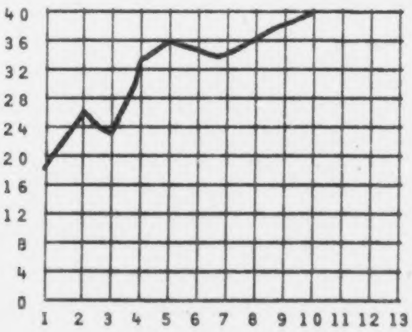


D. I. = .88

Disc. I = .10

Item-Score Corr. = .40

Question 12

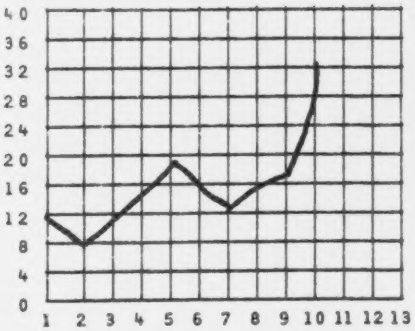


D. I. = .79

Disc. I = .23

Item-Score Corr. = .43

Question 13

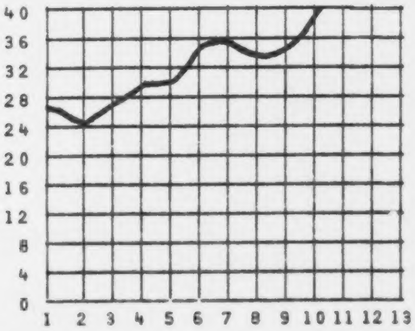


D. I. = .39

Disc. I = .14

Item-Score Corr. = .25

Question 14

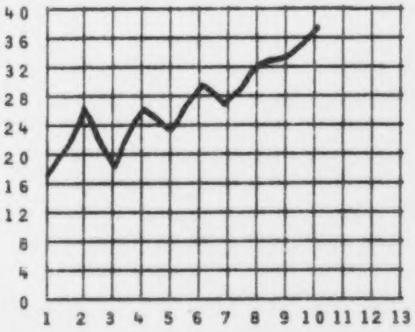


D. I. = .79

Disc. I = .20

Item-Score Corr. = .40

Question 15

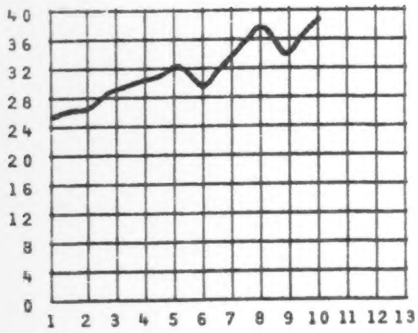


D. I. = .67

Disc. I = .25

Item-Score Corr. = .43

Question 16

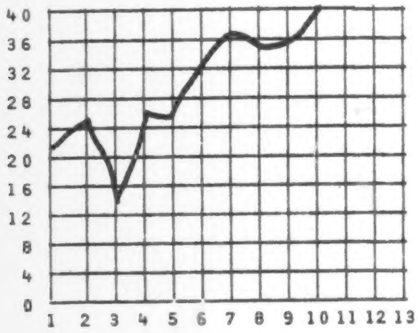


D. I. = .78

Disc. I = .15

Item-Score Corr. = .39

Question 17

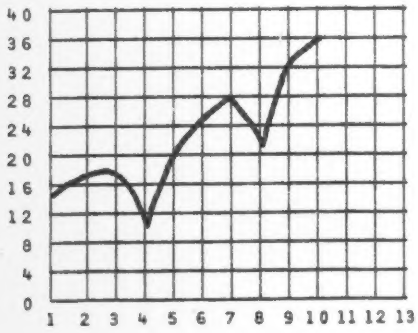


D. I. = .73

Disc. I = .35

Item-Score Corr. = .46

Question 18

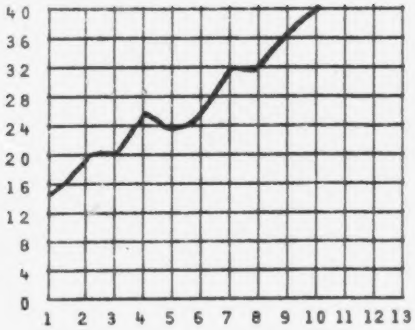


D. I. = .54

Disc. I = .31

Item-Score Corr. = .41

Question 19

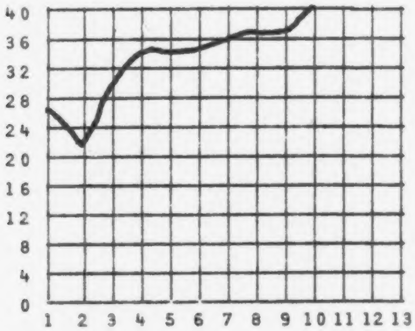


D. I. = .67

Disc. I = .31

Item-Score Corr. = .45

Question 20

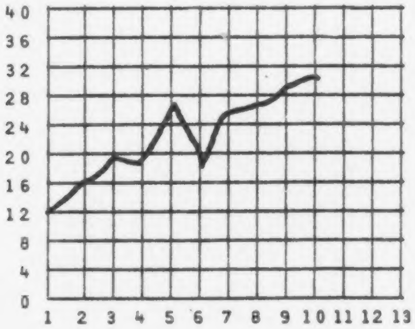


D. I. = .87

Disc. I = .18

Item-Score Corr. = .43

Question 21

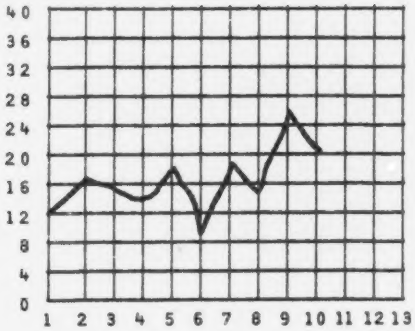


D. I. = .55

Disc. I = .20

Item-Score Corr. = .35

Question 22

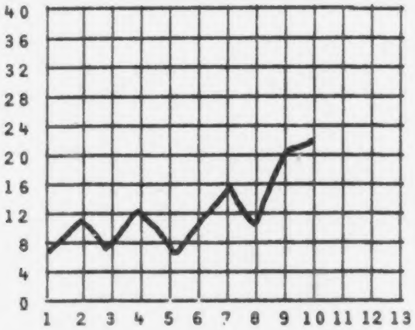


D. I. = .40

Disc. I = .08

Item-Score Corr. = .19

Question 23

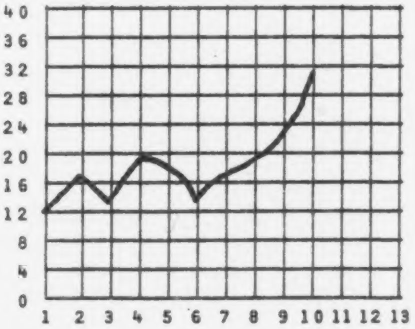


D. I. = .29

Disc. I = .18

Item-Score Corr. = .28

Question 24

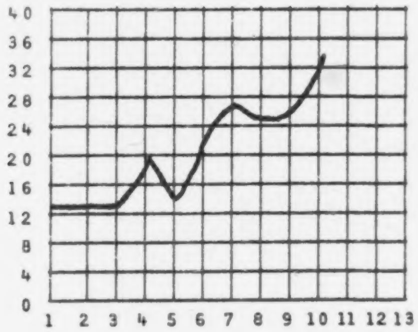


D. I. = .45

Disc. I = .12

Item-Score Corr. = .27

Question 25

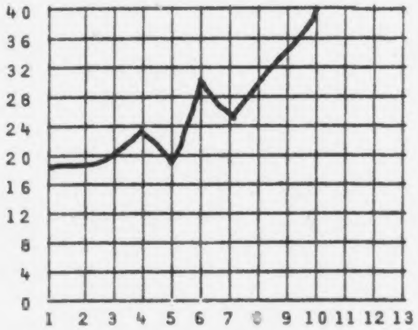


D. I. = .51

Disc. I = .30

Item-Score Corr. = .31

Question 26

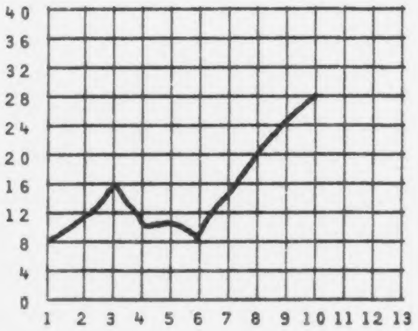


D. I. = .65

Disc. I = .29

Item-Score Corr. = .42

Question 27

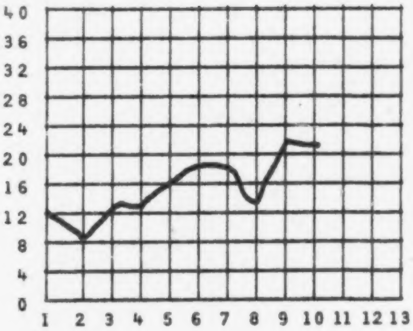


D. I. = .37

Disc. I = .20

Item-Score Corr. = .21

Question 28

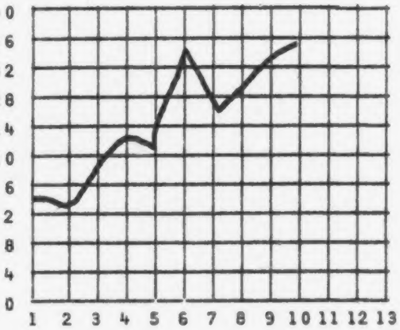


D. I. = .37

Disc. I = .15

Item-Score Corr. = .15

Question 29

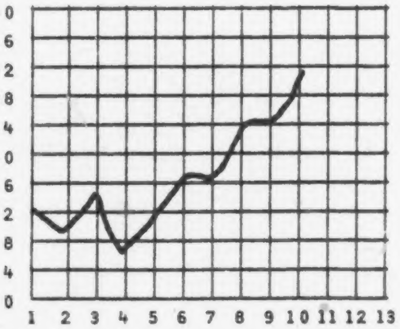


D. I. = .62

Disc. I = .35

Item-Score Corr. = .42

Question 30

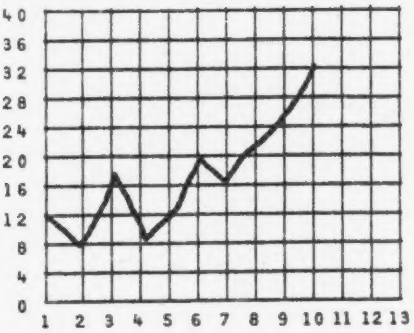


D. I. = .42

Disc. I = .29

Item-Score Corr. = .37

Question 31

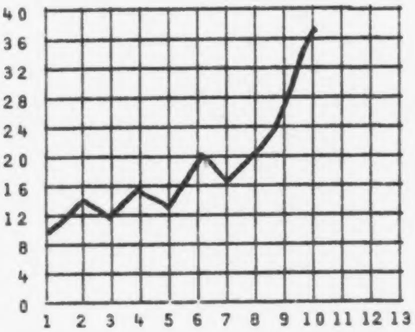


D. I. = .44

Disc. I = .29

Item-Score Corr. = .37

Question 32

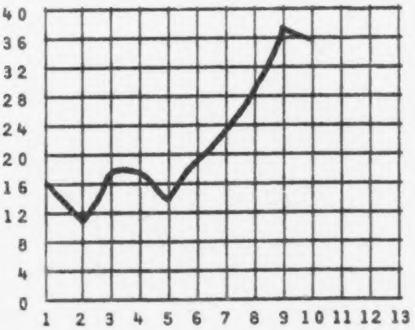


D. I. = .45

Disc. I = .28

Item-Score Corr. = .31

Question 33

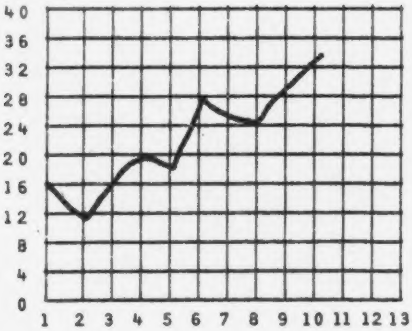


D. I. = .56

Disc. I = .33

Item-Score Corr. = .45

Question 34



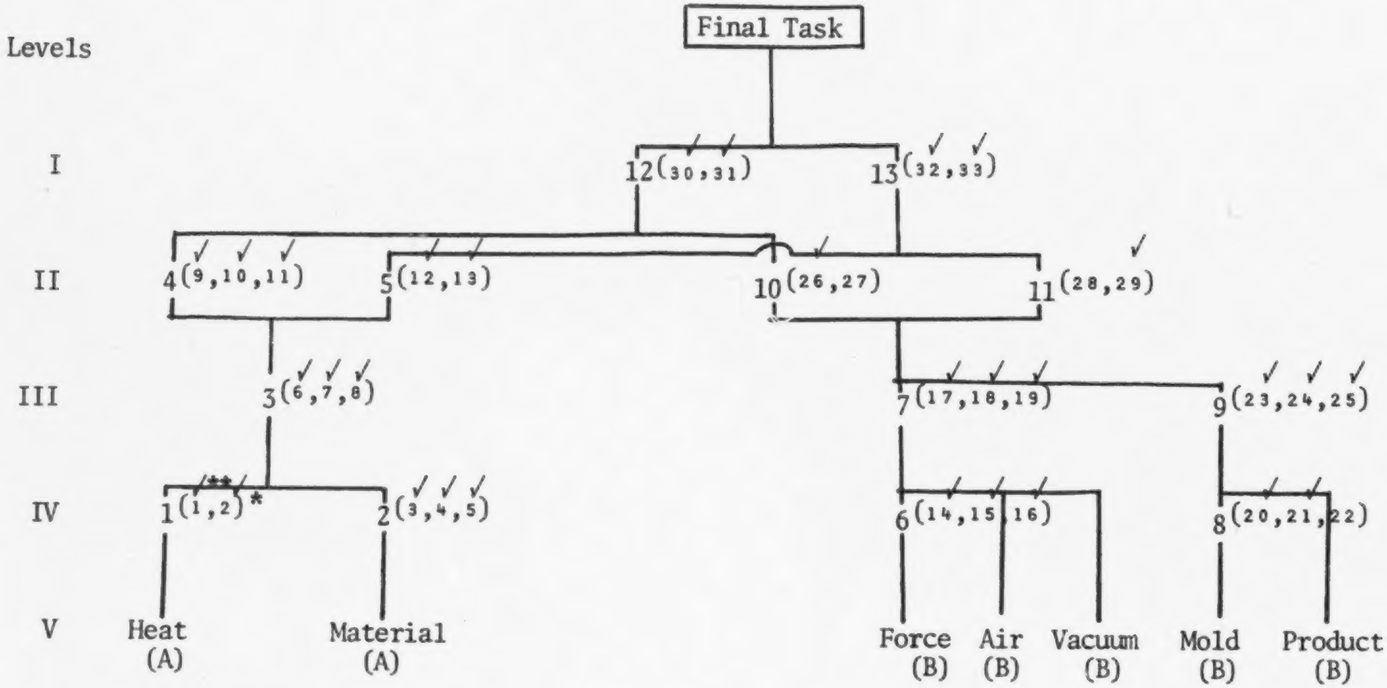
D. I. = .57

Disc. I = .29

Item-Score Corr. = .40

I-A

Learning Task Diagram


Final Task
Levels
I
II
III
IV
V
12(30,31)
13(32,33)
4(9,10,11)
5(12,13)
10(26,27)
11(28,29)
3(6,7,8)
7(17,18,19)
9(23,24,25)
1(1,2)*
**
2(3,4,5)
6(14,15,16)
8(20,21,22)
Heat (A)
Material (A)
Force (B)
Air (B)
Vacuum (B)
Mold (B)
Product (B)

* Test item numbers per task

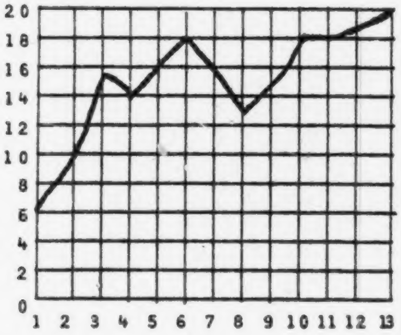
** Items with item-score correlation above .25

APPENDIX W

ITEM DISCRIMINATION CURVES, DISCRIMINATION INDEXES, DIFFICULTY INDEXES, AND ITEM-SCORE CORRELATIONS USED TO EVALUATE THE LEARNING ACHIEVEMENT TEST ADMINISTERED TO SENIOR HIGH STUDENTS

ITEM DISCRIMINATION CURVES, DISCRIMINATION INDEXES, DIFFICULTY INDEXES, AND ITEM-SCORE CORRELATIONS USED TO EVALUATE THE LEARNING ACHIEVEMENT TEST ADMINISTERED TO SENIOR HIGH STUDENTS

Question 1

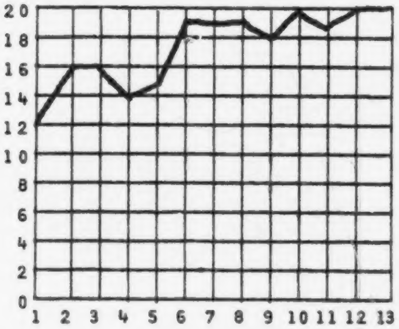


D. I. = .77

Disc. I = .18

Item-Score Corr. = .37

Question 2

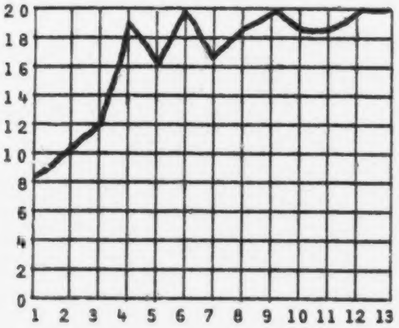


D. I. = .88

Disc. I = .08

Item-Score Corr. = .33

Question 3

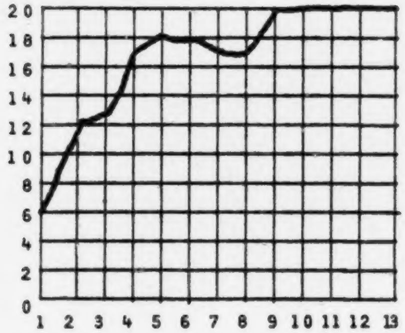


D. I. = .85

Disc. I = .17

Item-Score Corr. = .47

Question 4

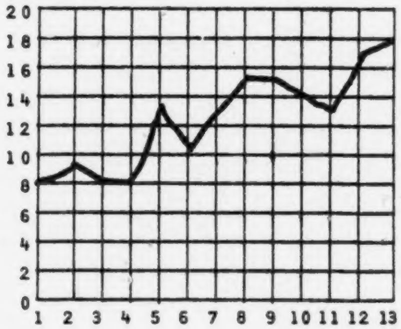


D. I. = .83

Disc. I = .29

Item-Score Corr. = .49

Question 5

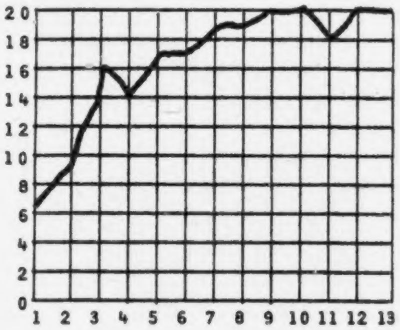


D. I. = .62

Disc. I = .30

Item-Score Corr. = .34

Question 6

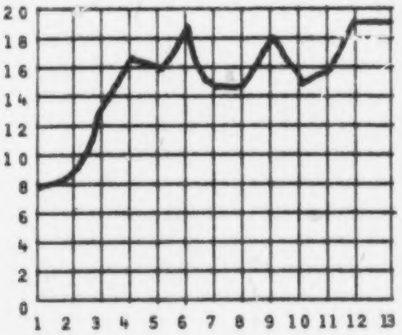


D. I. = .83

Disc. I = .14

Item-Score Corr. = .48

Question 7

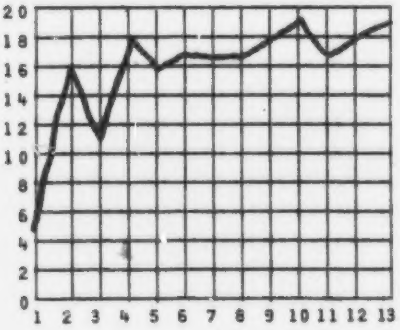


D. I. = .77

Disc. I = .16

Item-Score Corr. = .34

Question 8

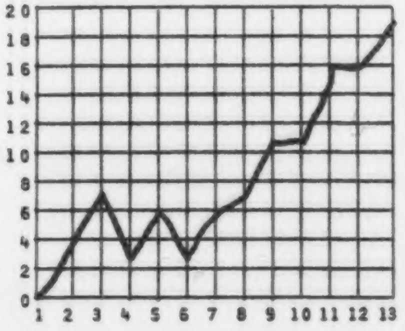


D. I. = .80

Disc. I = .17

Item-Score Corr. = .36

Question 9

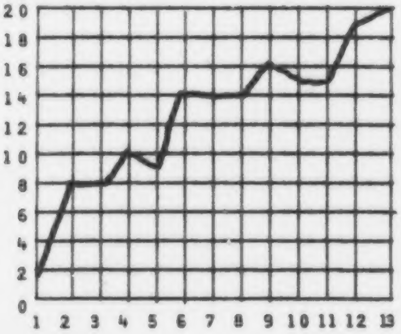


D. I. = .42

Disc. I = .47

Item-Score Corr. = .50

Question 10

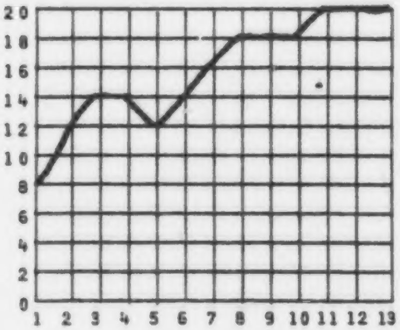


D. I. = .63

Disc. I = .40

Item-Score Corr. = .48

Question 11

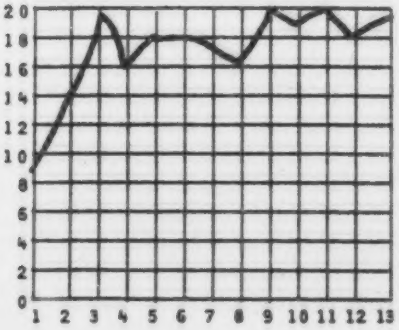


D. I. = .78

Disc. I = .34

Item-Score Corr. = .43

Question 12

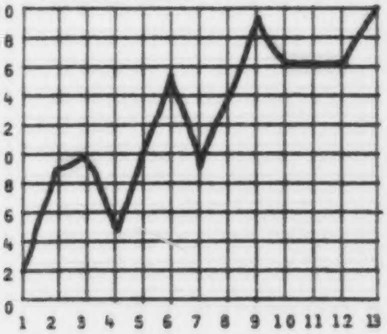


D. I. = .85

Disc. I = .17

Item-Score Corr. = .34

Question 13

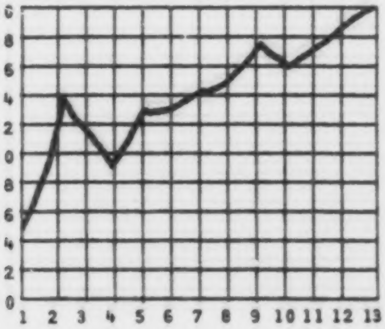


D. I. = .62

Disc. I = .42

Item-Score Corr. = .47

Question 14

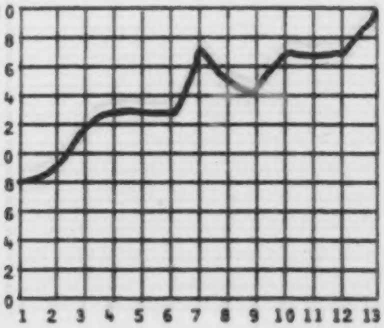


D. I. = .71

Disc. I = .32

Item-Score Corr. = .37

Question 15

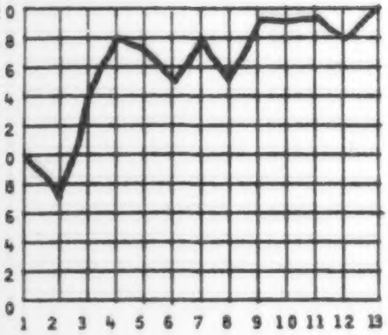


D. I. = .70

Disc. I = .27

Item-Score Corr. = .35

Question 16

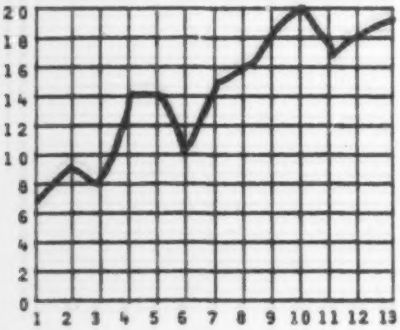


D. I. = .81

Disc. I = .23

Item-Score Corr. = .37

Question 17

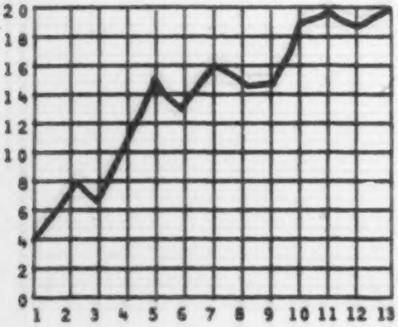


D. I. = .72

Disc. I = .39

Item-Score Corr. = .45

Question 18

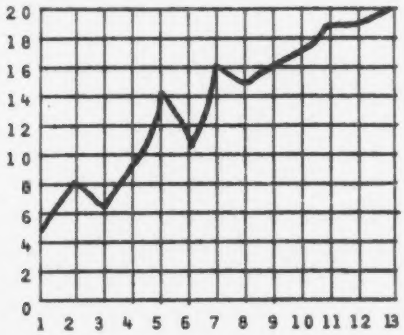


D. I. = .70

Disc. I = .22

Item-Score Corr. = .52

Question 19

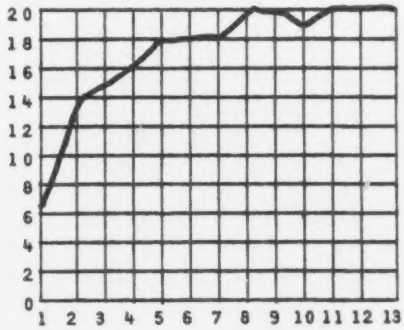


D. I. = .67

Disc. I = .53

Item-Score Corr. = .47

Question 20

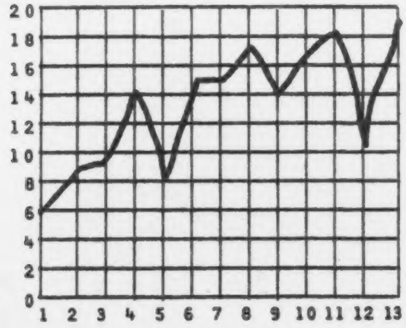


D. I. = .87

Disc. I = .21

Item-Score Corr. = .48

Question 21

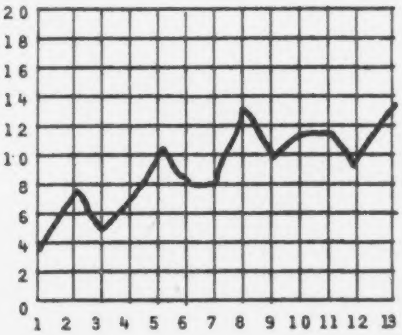


D. I. = .65

Disc. I = .35

Item-Score Corr. = .34

Question 22

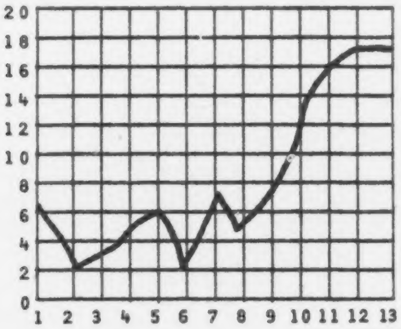


D. I. = .45

Disc. I = .26

Item-Score Corr. = .23

Question 23

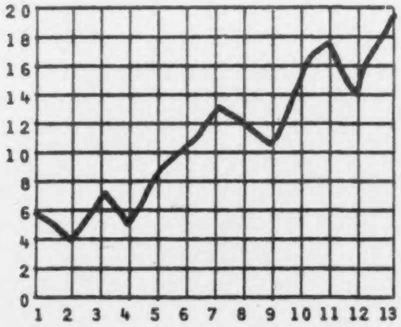


D. I. = .41

Disc. I = .51

Item-Score Corr. = .45

Question 24

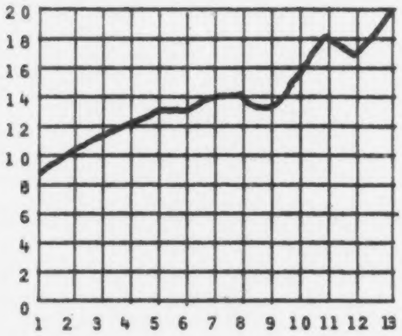


D. I. = .54

Disc. I = .49

Item-Score Corr. = .43

Question 25

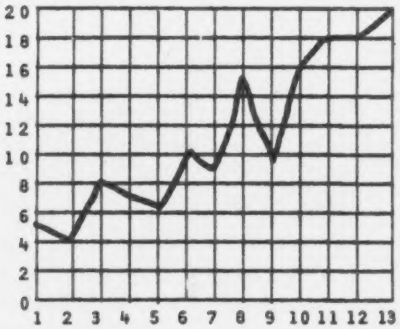


D. I. = .69

Disc. I = .30

Item-Score Corr. = .32

Question 26

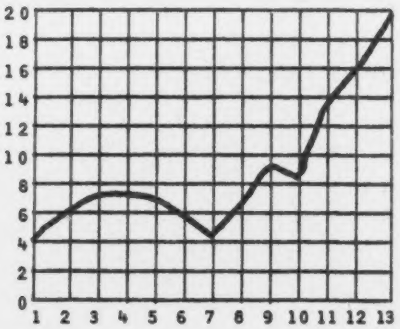


D. I. = .56

Disc. I = .56

Item-Score Corr. = .50

Question 27

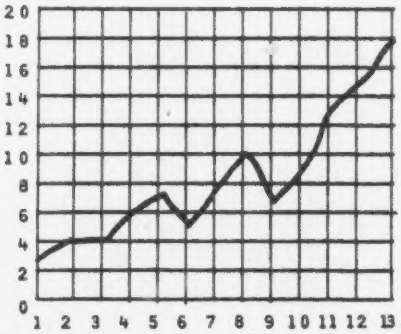


D. I. = .43

Disc. I = .34

Item-Score Corr. = .35

Question 28

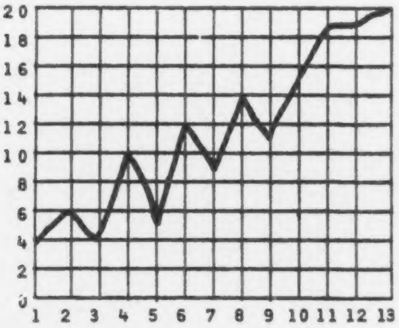


D. I. = .42

Disc. I = .43

Item-Score Corr. = .41

Question 29

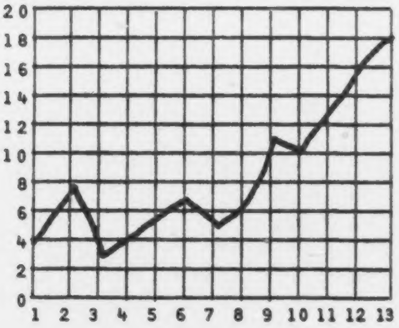


D. I. = .57

Disc. I = .57

Item-Score Corr. = .53

Question 30

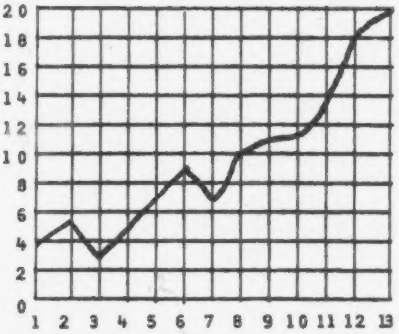


D. I. = .43

Disc. I = .42

Item-Score Corr. = .42

Question 31

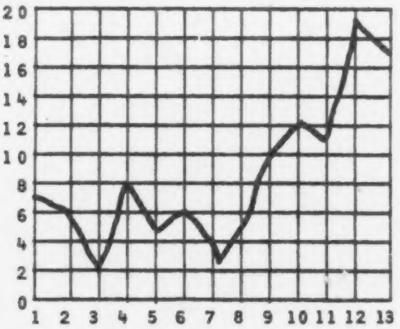


D. I. = .48

Disc. I = .51

Item-Score Corr. = .48

Question 32

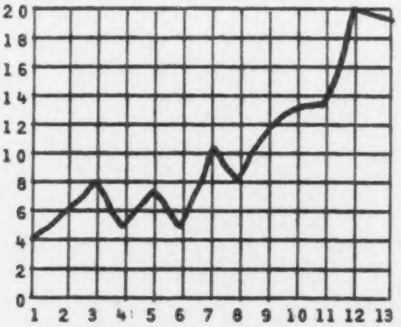


D. I. = .42

Disc. I = .41

Item-Score Corr. = .38

Question 33

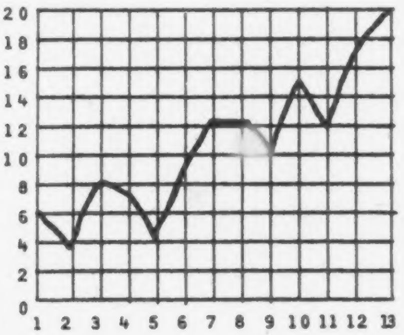


D. I. = .50

Disc. I = .50

Item-Score Corr. = .46

Question 34



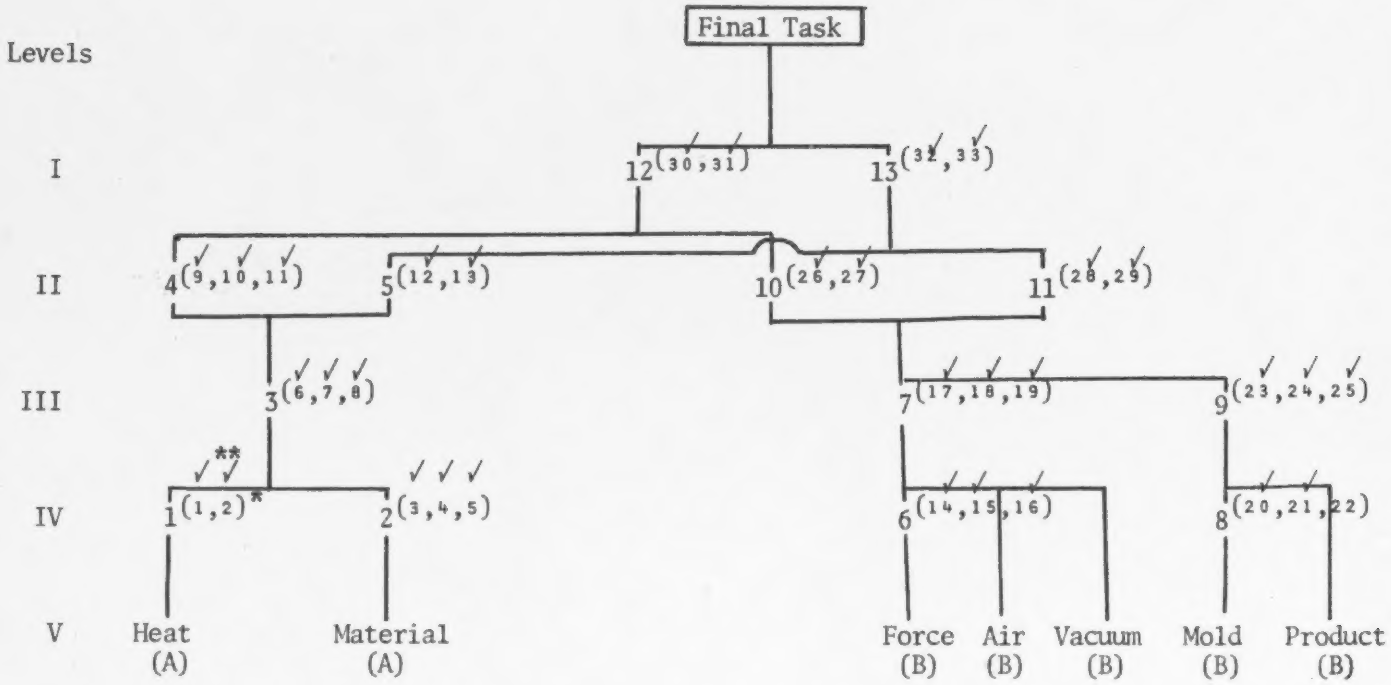
D. I. = .54

Disc. I = .35

Item-Score Corr. = .45

I-A

Learning Task Diagram


Final Task
Levels
I
II
III
IV
V
12 (30,31)
13 (32,33)
4 (9,10,11)
5 (12,13)
10 (26,27)
11 (28,29)
3 (6,7,8)
7 (17,18,19)
9 (23,24,25)
1 (1,2)*
**
2 (3,4,5)
6 (14,15,16)
8 (20,21,22)
Heat (A)
Material (A)
Force (B)
Air (B)
Vacuum (B)
Mold (B)
Product (B)

* Test item numbers per task

** Items with item-score correlation above .32